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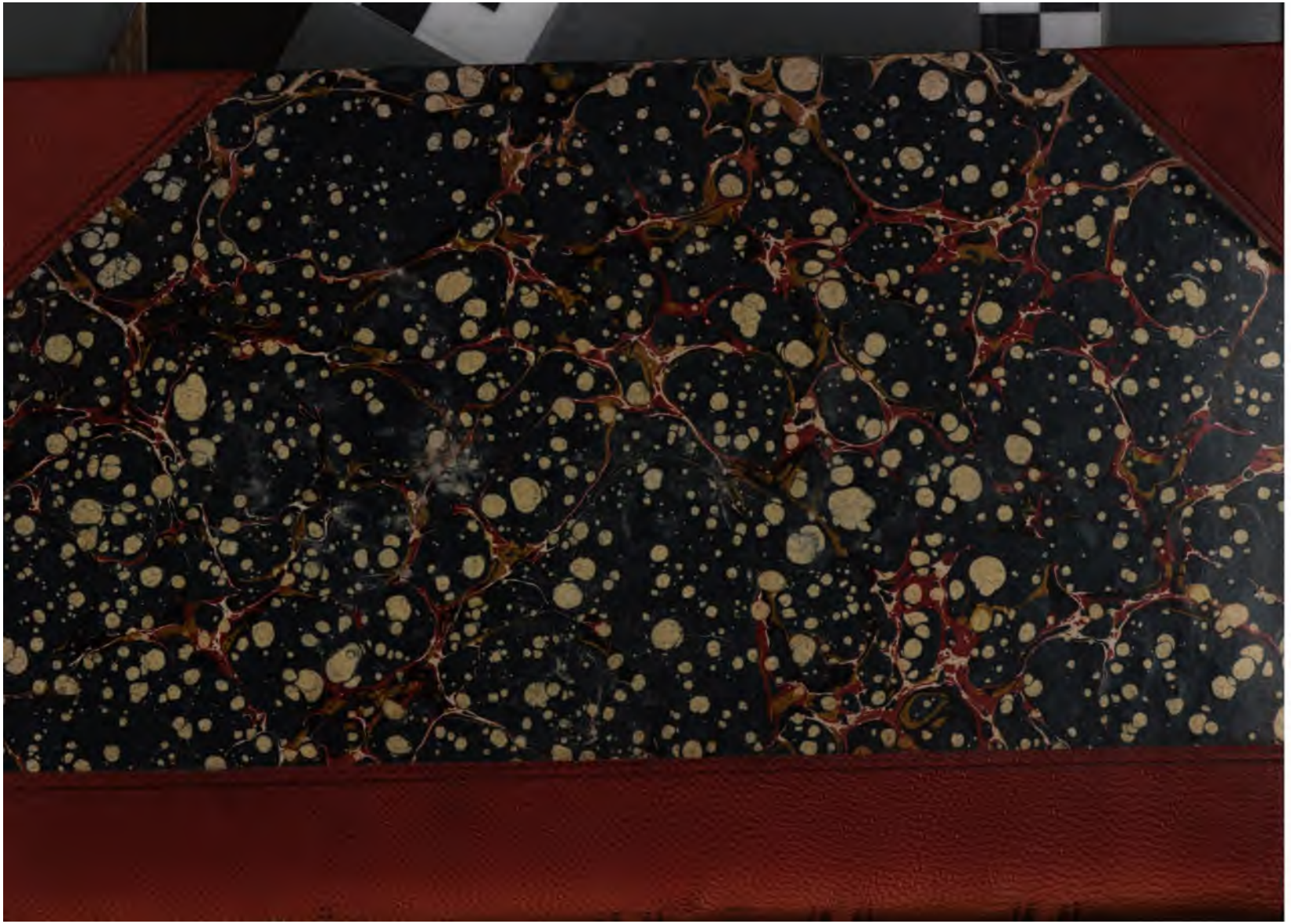

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TRANSACTIONS

OF THE

MANCHESTER

GEOLOGICAL SOCIETY.

VOLS. VI. and VII.

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TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 1.] VOL. VI. [Session 1866-67.

The Annual Meeting of the Members of the Manchester Geological Society was held in the Museum, Peter Street, on Thursday, October 25th, 1866.

E. W. BINNEY, Esq., F.R.S., F.G.S., President, in the Chair.

The Chairman said they were met for the purpose of receiving the reports of the Society and for electing officers for the ensuing year; but before going to business he must state that their position, as occupants of that building, was just about in the same uncertain state that it was last year. They were there under the roof of the Natural History Society, and that Society at present had come to no determination as to what they were going to do. The Societies were a good deal linked together. Of course it was not absolutely essential that if the Natural History Society ceased to exist, that they also should suspend their functions. The two Societies had joined their collections, but there was no reason why these should not be again separated. He knew almost all the specimens in the collection, what they brought with them, and what belonged to the Natural History Society. What their legal powers

were he believed had not been very well looked into, and he did not know that any one could well give an opinion on the point. When the Societies united, it was thought that the Geological Society would die directly, and though provision was made in the event of this contingency, no arrangement was made in case the Natural History Society expired first. As a matter of equity, what was good for the one ought to be good for the other; and if the Natural History Society died first, their collection ought to go to the Geological Society. At present, however, it was no use debating the matter; so long as the Natural History Society continued they could not have better landlords. They paid no rent, and they had the use of the rooms and every facility afforded.

Mr. John E. Forbes, F.G.S., one of the Honorary Secretaries, then read the report of the Council and also of the Curators.

Report of the Council.

In resigning the office with which your Council have been entrusted during the past year, they present to the members of this Society, a report of the proceedings during that period, together with the Treasurer's account of the receipts and disbursements on account of the Society, a list of donations to the Library and Museum of the Society, and a list of papers read during the session.

During the past year seven new members have been elected, a few have withdrawn, and the present number of members is 183.

Your Council have again the satisfaction of announcing that the Treasurer's balance sheet is favourable, the balance in hand being £144 18s. 5d., as against £121 4s. 2d. at the commencement of the session. The donations to the Library this year have been very liberal: they include a complete set of the Transactions of the Indian Geological Survey.

With reference to ths relations existing between the Geological and Natural History Societies, your Council have to report that nothing has as yet been arranged.

A field-day and excursion was made on the 16th June, to Bacup and Todmorden; about thirty members joined, and although the day was not very favourable to investigation, much interesting and valuable information was obtained. An account of the excursion will shortly be presented to the Society.

The following papers have been read and published during the session.

LIST OF PAPERS READ, 1865-66.

1.—Opening Address,—"On some of the Objects of the Manchester Geological Society, and the best means of attaining them."—BY THE PRESIDENT, E. W. BINNEY, ESQ., F.R.S., F.G.S.

2.—"On Safety Cages."—BY MR. J. J. HORSFALL.

3.—"On the Union of the Gannister and Higher Foot Coal Mines at Bacup."—BY MR. JOHN AITKEN.

4.—"Notes on the *Lepidodendron Sternbergii* found at Poynton."—BY MR. G. C. GREENWELL, F.G.S.

5.—"On Geology in its relation to Archæology."—BY MR. CHARLES HARDWICK.

6.—"On the Geology and Fossils of the Lingula Flags, North Wales."—BY MESSRS. JOHN PLANT AND E. WILLIAMSON.

7.—"On a Fossil Shell from the Oil Wells of Canada."—BY MR. W. R. BARR.

8.—"On the Hæmatite Mines in the Ulverstone District."—BY MR. G. C. GREENWELL.

9.—"On the Best Methods to Produce Coal in a Marketable Condition."—BY MR. JOHN WARBURTON.

10.—"On recent evidences of Ancient Human Habitation in Poole's Cavern, Buxton."—BY MR. JOHN PLANT.

11.—"On the Existence of a Sea-Beach on the Limestone Moors, near Buxton."—BY MR. JOHN PLANT.

List of New Members Elected, 1865-66.

Mr. T. Boardman, Blackburn.
Mr. James Eccles, Blackburn.
Mr. Walter Evans, Oldham.
Mr. Wm. Mc. Murtrie, Manchester.
Mr. T. Marques, Church, near Accrington.
Mr. R. Pease, Barnsley.
Mr. A. Selby, Leigh.

Members who have Discontinued.

Mr. H. Bramwell.
Mr. G. Charlton.
Rev. S. H. Cooke.
Mr. T. R. Fairbank.
Mr. James Hertz.
Mr. R. Smith.
Mr. John Taylor.

Report of the Curators.

During the past year the following donations have been presented to the Society:—

LIST OF BOOKS RECEIVED.

American Journal of Science and Art. Nos. 120 and 121.

Smithsonian Report.—Washington, U.S A., 1864.

Report of Patents, U.S.A., 1861.

Reports of the Belfast Field Naturalists' Club, 1863-4,-1864-5.

Rules of the Birmingham Natural History and Microscopical Society, Midland Midland Institute, 1865.

Transactions of the Dudley and Midland Geological and Scientific Society and Field Club, 1865.

Journal of the Royal Dublin Society, 1865. No. 34.

Vice-President's Address to the Edinburgh Geological Society, 1866.

Journal of the Royal Geological Society of Ireland, 1865-6. Vol. i., part 2.

Memoirs of the Geological Survey of India, on the Coal of Assam, and District South. Vol. iv., part 3.

Geological Survey of India; Catalogue of Echinodermata, &c., Calcutta.

Annual Report of the Geological Survey of India, and Museum of Geology, Calcutta, 1864 and 1865.

Memoirs of the Geological Survey of India. Vol. v., part 1.

Quarterly Journal of the Geological Society, London. Nos. 84, 85, and 87.

Palæontographical Society, London. Vol. 18.

Report of the Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire, 1864-5. (Leeds 1866.)

Catalogue of the Library of the Philosophical and Literary Society of Leeds, 1866.

Annual Reports of the Leeds Philosophical and Literary Society, 1863-4-5.

Proceedings of the Liverpool Geological Society, 1865-6.

Description of some Fossil Plants in Lower Coal Seams of Lancashire and Yorkshire.—Presented by E. W. Binney, Esq.

Memoirs of the Literary and Philosophical Society of Manchester. Vol. ii. Third Series.

Proceedings of the Literary and Philosophical Society of Manchester. Vols. ii, iii, and iv.

Proceedings of the South of Wales Institute of Engineers, April, 1866. Parts 1, 4, & 5.

Catalogue of the Collection of Fossils in the Museum of Practical Geology, London, 1865.

Nouvelles Recherches sur les Poissons Fossiles, Du Mont Liban, Par MM. F. J. Pictet et A. Humbet, Juin, 1866.

Veiviser ved Geologiske Excursioner, I. Christiania Omegn, af Lector Theodor Kjerulf, Christiania, 1865.

Om De I Norge Forekommende Fossile Dyrelevninger. Fra Qvartærperioden, af Prof. M. Sars, Christiania, 1865.

Om Sneebræen Folgefon af S. A. Sexe, Christiania, 1864.

Om De Geologiske Forhold Paa Kyststrækningen af Nordre Bergenhus Amt, af M. Irgens og Th Hiortdahl.

Atti dell'Accademia di Scienze e Lettere di Palermo 1853. Vol. ii.

MANCHESTER GEOLOGICAL SOCIETY.

BALANCE SHEET, 1866.

Abstract of Receipts.

1865.	£	s.	d.
To Balance brought down	121	4	2
,, Subscriptions, 1865-66	119	0	0
,, Half-Subscription, 1866	0	10	0
,, Arrears of former years	13	0	0
,, Interest from Bank	3	1	8
,, Dividends	7	7	6
,, Proceedings sold	1	3	0
	£265	6	4

Abstract of Payments.

1866.	£	s.	d.
By Library	2	13	9
,, Reports of Meetings	66	10	0
,, Reporters	10	10	0
,, Printing and Stationery	4	5	2
,, Postages, Delivery of Proceedings, &c.	24	11	6
,, Collector's Commission	6	12	6
,, Gratuity to Mr. Parker	5	5	0
	£120	7	11
,, Balance in Bank £141 12 11 ..			
,, ,, with Treasurer 3 5 6 ...	144	18	5
	£265	6	4

1866, October. To Balance brought down £144 18 5

Examined and found correct,
22nd October, 1866.
R. D. DARBISHIRE, Auditor.

HENRY M. ORMEROD, Treasurer,
3rd October, 1866

The Chairman again remarked on the uncertainties of their position. If they were to find a place for their collection nothing could be done without the expenditure of a large sum of money. He believed if they had to start a new Society—a Cosmical Society, or something of that kind—they should have great numbers joining them; the custom there was to leave old Societies to linger out and to start something new. The Chairman then moved that the reports read be adopted, entered in the minutes, printed, and circulated amongst the members.

Mr. Forbes seconded the resolution, which was carried.

The next business was the election of officers for the ensuing year; and—

Mr. Greenwell, F.G.S., said he had very great pleasure in proposing, as their President, Mr. E. W. Binney, a gentleman whose name stood high enough to entitle him to a far higher position than any they could offer him. That Society was, moreover, so much indebted to Mr. Binney, for all that he had done, that any tribute they could pay him would fall far below his merits.

Mr. Chattwood had great pleasure in seconding the resolution.

Mr. Aitkin, in supporting it, said he could reiterate all that had been said, and he felt extremely proud that they were about to re-elect Mr. Binney to the office of President of that Society. He was an ornament to it, and he hoped he would be long spared to contribute those services which had been so eminent during a long life-time.

The resolution was carried.

The Chairman said he was much obliged to them for their kindness in proposing him as President for another year. He did not know whether they had exercised their discretion rightly, but he could not help but thank them for the confidence they had reposed in him. He had not gone to live out of the neighbourhood, but, if he had to leave Manchester, he should not like to hold an office, the duties of which he could not perform. He then said he believed it was rather an unusual course to propose the President separately, they had usually had the whole list of officers submitted to them.

Mr. Forbes then proposed as *Vice-Presidents*—John Aitken, Esq., Joseph Chattwood, Esq., R. A. Eskrigge, Esq., F.G.S., G. C. Greenwell, Esq., F.G.S.; and as the Council the following gentlemen: *Treasurer*—Henry Mere Ormerod, Esq., *Auditors*—R. P. Greg, Esq., F.G.S., R. D. Darbishire, Esq., F.G.S.; *Honorary Curators*—Mr. E. W. Binney, Mr. H. M. Ormerod; *other Members of the Council*—Messrs. W. R. Barr, F.G.S., T. P. Charlton, Thomas Farrimond, G. Gilroy, C. Hardwick, J. J. Horsfall, James Hodgson, Andrew Knowles, R. M. Knowles, Thomas Livesey, J. Stott, John Wild; *Representatives of this Society at the Council Meetings of the Natural History Society*—E. W. Binney, F.R.S., F.G.S., Dr. J. P. Joule, LL.D., F.R.S.

The resolution was duly adopted.

The Chairman thought he might be allowed to propose another resolution. He was sure that one of the most onerous offices of that Society was that of Secretary. They could do nothing without a good Secretary, and the Secretary had other duties than merely attending to those meetings. He had the whole of the correspondence; he had to attend to the minutes; he had to look at the papers which were to be printed, and superintend the printing for the Society. He really thought a Secretary the chief man of the Society. They had had the services of Mr. Forbes now for several

years, and he was sure they could have no one better; they had tried him by the test of experience, which was one of the best means of judging; and the only thing about Mr. Forbes was whether they had not worked him long enough, and should put him to some easier post. He hoped, however, that Mr. Forbes would give them his services for another year. They had always had a coal proprietor along with the Secretary. Mr. Clegg Livesey was another gentleman who, they hoped, would give every attention to the mining part of the office. He begged leave to propose that Mr. John E. Forbes and Mr. Clegg Livesey be the Honorary Secretaries for the ensuing year.

Mr. Chattwood seconded the resolution, which was carried

Mr. Hodgson proposed that a vote of thanks be given to the President, Vice-Presidents, Secretaries, and Council, for their valuable services during the past year.

The resolution was seconded by Mr. Newall, and adopted.

The Chairman, in acknowledging the vote, said it was now thirty years since he became a member of the Society, and though not a very old man, he was one of the oldest, if not the oldest member. They had gone on better and worse ever since. He did not think the Society was ever in a much better state than it was at present. For himself he should be glad to render any little service to the Society, and he thought all his colleagues would be inclined to do the same.

The next business was to consider the alteration of a rule, of which due notice had been given. By rule 15, the annual meeting of the Society must be held on the last Thursday in the month of October, and it was proposed to omit the words "on the last Thursday" out of the rule, so as to leave the day open.

Mr. Aitken moved a resolution to this effect, which was seconded by Mr. Forbes, and carried.

This concluded the formal business of the annual meeting, and a conversation arose as to the desirabiliy of more frequent excursions.

Mr. Chattwood said that he and others had an excursion about three weeks ago, when they saw Mr. Spencer, at Sunnyside, who was most desirous that the Society should visit that locality.

The Chairman thought this spot a very good one. The only thing about these excursions was, to have a committee to superintend them. It was always interesting to look at the great valleys they had in Lancashire, and judge for themselves as to how they had been formed. He thought probably if they came to look, they would see that atmospheric agency and subaërial work for a long series of ages, and the sea, and probably chemical action as well, had all done their share of work.

Mr. Chattwood thought the subject would be better discussed on the spot; and just to try the thing, he thought they would have more life in their Society if they had more of these excursions. He believed they were very easily got up, the difficulty—if there was any difficulty at all—was in getting a man to stand godfather. Now he should be very happy to stand godfather for one, and he thought he could get three or four more who would also do it with very great pleasure. He would move that they had at least three excursions during the next year.

The Chairman suggested that an excursion committee should be included in the resolution; it was then moved "That three

"excursions, at least, be made during the ensuing year, and that the "President, Honorary Secretaries, and Messrs. Chattwood and "Aitken, (with power to add to their number) be a Committee to "make arrangements."

After passing a vote of thanks to the Chairman for presiding, the business of the meeting terminated.

OFFICERS AND COUNCIL FOR 1866-67.

President:

E. W. BINNEY, Esq., F.R.S., F.G.S.

Vice-Presidents:

JOHN AITKEN, Esq.
JOSEPH CHATTWOOD, Esq.
R. A. ESKRIGGE, Esq., F.G.S.
G. C. GREENWELL, Esq., F.G.S.

Treasurer:

HENRY MERE ORMEROD, Esq.,

Auditors:

R. P. GREG, F.G.S. | R. D. DARBISHIRE, F.G.S.

Honorary Secretaries:

JOHN EDWARD FORBES, F.G.S. | Mr. CLEGG LIVESEY.

Honorary Curators:

Mr. E. W. BINNEY. | Mr. H. M. ORMEROD.

Other Members of the Council:

Mr. W. R. Barr, F.G.S.
„ T. P. Charlton.
„ Thomas Farrimond.
„ G. Gilroy.
„ C. Hardwick.
„ J. J. Horsfall.
Mr. James Hodgson.
„ Andrew Knowles.
„ R. M. Knowles.
„ Thomas Livesey.
„ James Stott.
„ John Wild.

Representatives of this Society at the Council Meetings of the Natural History Society,—E. W. Binney, Esq., F.R.S., F.G.S.; Dr. J. P. Joule, LL.D., F.R.S.

MANCHESTER GEOLOGICAL SOCIETY.

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Nuttall, Thomas, Colliery Surveyor, Bury.

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TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 2.] VOL. VI. [Session 1866-67.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday Afternoon, November 27th, 1866.

E. W. Binney, Esq., F.R.S., F.G.S., President, in the Chair.

The Chairman stated that during their excursion to Bacup the other day, he showed some of the members what he thought were garnets, found in the roof of the Feather Edge coal. Some specimens which he showed on the top of Fo Edge were not so good as the specimens he had now brought, and to which he invited the attention of the members. He believed some of the gentlemen doubted that the specimens he exhibited during the excursion were really garnets, but he thought no doubts whatever would be attached to the specimens now produced. He also wished to show a few specimens of coal plants from the Vosges, sent to him by Professor Schimper, of Strasbourg. The age of these fossils had been a good deal disputed. One class of geologists said they belonged to the Cambrian series, another to the Silurian, and another to the Devonian. The fossils (exhibited) consisted of a *Cyclopteris*, a

beautiful *Sphenopteris*, and a *Dadoxylon*. He had never visited the country, but from the nature of the fossils they appeared very like some of our lower coal-measure fossils. The President also called attention to a work on the table, "Le Terrain de Transition des Vosges," by M.M. J. Kroechlin, and Professor Schimper, which was most beautifully illustrated. He did not know whether Government afforded any assistance in such matters, but the work was a surprising production for a town like Strasbourg, and contrasted with the way in which scientific works were got up in a town of the size and importance of Manchester.

Mr. Chattwood proposed that the best thanks of the meeting be given, through the Secretaries, to Thomas Brooks, Esq., as the inviter and host on the occasion of the recent visit of the Society to his quarries at Fo Edge and elsewhere.

Mr. Eskrigge seconded the motion, which was unanimously adopted.

Mr. Aitken then read the following paper:—

EXCURSION OF THE

MANCHESTER GEOLOGICAL SOCIETY

TO BACUP AND TODMORDEN;

BY JOHN AITKEN, ESQ.

IT will be remembered that at a meeting of this Society, held on the 29th of May, of the present year, it was resolved that an

excursion of the members should take place on the 16th of the following month, to Bacup and Todmorden, for the purpose of examining the geological features of that district, and that a Committee, consisting of the Honorary Secretary, Mr. J. E. Forbes, and the writer, was appointed to make the necessary arrangements for carrying the said resolution into effect. The Secretary, accordingly, informed each of the members, by circular, of the contemplated excursion, soliciting their co-operation and attendance; he also succeeded in making arrangements for issuing return tickets on very reasonable and satisfactory terms, with the Lancashire and Yorkshire Railway Company; for whose liberality the Committee, in the name of the Society, beg to tender their acknowledgments and thanks.

At the appointed time a number of the members and friends of the Society, consisting of the President, Mr. E. W. Binney, F.R.S., F.G.S., Messrs. E. H. Birkenhead, F.G.S., John E. Forbes, F.G.S., G. C. Greenwell, F.G.S., C. Hardwick, J. Hodgson, Andrew Knowles, John Knowles, R. M. Knowles, J. Parker, J. Plant, F.G.S., G. Wild, J. Wild, Senr., and J. Wild, Junr., &c., assembled at the Victoria Station, Manchester, and proceeded under the leadership of the President, to Bacup, where they were met by Messrs. J. Aitken, T. Aitken, T. Baldwin, J. Chattwood, J. Eccles, R. Eskrigge, F.G.S., S. Hall, J. Kerr, T. Newbigging, and W. J. Sleath. The assembled party first proceeded to inspect a section of the Rough Rock presented in a quarry near the Co-operative Store in Bacup, in the middle of which is exhibited the sand-rock on Feather Edge mine, being about fourteen inches thick, with a rock-roof, and resting upon an under-clay averaging about two feet six inches in thickness, in which the President pointed out the occurrence of flattened impressions of radicles or rootlets of *Stigmaria Ficoides*. The peculiar structure of this coal, (viz: the feather-edge character which prevails in the neighbourhood of Bury, and which has given rise to

the name by which it is generally known in the district,) does not obtain here.

After partaking of refreshment, a quarry, near Nut Mill, on the Greave Brook, worked in the Woodhead Hill Rock, (the first grit above the Rough Rock) was visited. The false bedding, which forms so prominent a feature of this rock, was pointed out and commented upon. The stone obtained possesses but slight value for building purposes. Thence the party proceeded up Oaken Clough, where the last-named grit was again met with in the bed of the stream above Greens Mill. After passing through a thick bed of black shale, in which ironstone nodules are found, the lower foot coal was examined, at its outcrop, under a waterfall, behind Oaken Clough Mill, it is here about eight inches thick, and has a black shale roof. At Ending, near Rochdale, where this coal has been worked, fish remains of several species have been found in it in moderate abundance. Very near the same place the Gannister coal, the principal mine of Bacup, is well exposed under a cascade formed by a stream of water from a small lateral valley, falling over a considerable thickness of rock, which here forms the roof of the Gannister mine; the coal appears to be about thirty inches thick, and reposes as usual upon a bed of fire-clay. No true Gannister is found here, or at any other place in the neighbourhood on the east of Bacup. A remarkable and interesting instance of disturbance, having taken place in the conditions under which the coal was deposited, probably affected subsequently by the operation of denuding forces, was clearly exhibited near the centre of this section where the seam of coal became abruptly reduced to seven inches in thickness. The rock-roof usually rests immediately upon the coal, but here it rises at a considerable angle towards the right hand, thus allowing a bed of shale, four feet six inches in the deepest part, to be interposed between it and the reduced bed of coal. An animated discussion, in which several members took part, arose as to the causes which had produced the phenomena here presented. Following the course of the stream

in the direction of Hoyle Hey, after passing for some distance over the roof-rock of the Gannister coal, the position of the Higher Foot, on Spanish Juice Mine, was pointed out by the writer, it was, however, concealed from view by a bed of drift, which is found here in considerable force on the flat ground, just before it disappears against the steeper slope of the hill, a little higher up.

As previously explained in a paper read by the writer before this Society, in December of last year, the Higher Foot becomes united to the Gannister coal about two miles east of Bacup, by the gradual attenuation of the intercalated rock previously alluded to as the Gannister roof-rock. After the union of the two seams the coal becomes thicker, is worked and considered as one bed, and is known as the Five Feet Mine. The roof also changes from rock to black shale, charged with round concretionary nodules in which abundance of *Goniatites*, *Aviculopecten*, and *Posidonia* are embedded.

A short distance above Hoyle Hey Farm House, and at a little higher elevation than that to which the true drift attains, a thick bed of sand, clay, and gravel, full of large angular and sub-angular blocks of grit stone, heaped together without any indication of stratification, in one confused mass, was noticed in the bank on the side of the Clough; the stones and pebbles were all of local origin, and had been but slightly affected by the abrading influence of water. No pebbles of an age anterior to the carboniferous era were detected.

Mr. Binney remarked that he had met with similar accumulations in other localities under analogous circumstances. No satisfactory explanation as to its origin was given.

A little higher up the stream and near to the adit of Hoyle Hey Colliery, a thin band of coal about one inch thick was seen in the bank, and under it a considerable depth of fire-clay. It is somewhat remarkable that this attenuated vein of coal should possess so

great a degree of persistency. It has been traced by the writer over an area of many square miles, it is in no instance absent from any of the exposed sections in the locality, nowhere does it attain a greater thickness than two inches, nor is it found without its accompanying thick bed of under-clay. About one hundred yards further on, the Forty Yards Mine was found cropping out on the side of the Clough, resting upon its associated bed of fire-clay. This coal is about seventeen inches thick, and is the highest workable seam of the Lancashire lower coal-measures. It has for several years been worked here and at numerous other places in the neighbourhood along its outcrop, on the hill sides, it yields a good serviceable furnace coal, but from the prevalence of iron pyrites is not well calculated for domestic use. The fire-clay underlying it furnishes a valuable material for the manufacture of bricks and tiles, for which purpose it is extensively employed; the black shale forming the roof of this coal contains organic remains, although rather sparingly.

A vigorous attack was commenced by several of the party upon a quantity of shale, which had recently been brought out of the pit in working, in the hope of discovering some of the hidden treasures entombed therein. Slight success, however, attended their efforts. One gentleman succeeded in laying open a portion of a *Palæoniscus*, and a few detached fish scales were found by other members of the party.

Passing over a thick bed of shale, a quarry was next visited on Reaps Moss. The rock here exposed is a fine-grained greyish grit, exhibiting remarkable indentations and trail-like markings on the upper surfaces of the various layers into which the substance forming the overlying slabs has penetrated, producing protuberances of a very striking character, which are visible on the under-surface when the blocks are raised. A few specimens, presenting the peculiar characteristics of this rock, were some time ago exhited to the members of this Society by the writer. It is difficult

to assign a satisfactory reason for the phenomena here presented. The most popular explanation given, is that which attributes the deep irregularly formed indentations to the escape of bubbles of gas through soft mud, and the trail-like grooves to the motion of *Annelids*, *Crustaceans*, or *Univalves*, over the soft muddy surface during the period of deposition. It is a subject, however, upon which great diversity of opinion exists, and one to which the attention of geologists might be profitably directed, with the view of elucidating the difficulties which surround it.

The party after leaving this quarry passed along Reaps Moss, and ascended Tooter Hill, on the crest of which a coarse soft crumbly sandstone has been quarried. Good examples of false bedding were observed on the face of the exposed rock. A difficulty having arisen in the minds of some of the members as to the exact geological position of this rock, it was suggested by Mr. Binney that it corresponded to the grit found in the neighbourhood of Staleybridge, and known as the Gorse Hall rock. During the examination of this quarry, Mr. Baldwin discovered in one of the detached blocks of stone, a beautiful specimen of *Calamites*, embedded in and surrounded by a dark substance, which appeared to be an outer cylinder of ligneous structure, and which the President considered as confirmatory evidence of the view which he had previously expressed, namely, that the *Calamites* was not a separate and distinct vegetable form as formerly believed, but that it was the central exis of a larger stem, having one or more outer cylinders of woody tissue, probably belonging to the well-known exogenous hard-wooded trees often met with in our coal-fields. The specimen has since been detached from the block by the writer, and, as will be remembered, was exhibited at a subsequent meeting of this Society, when the President made some explanatory remarks upon it, and stated it was one of the best and most instructive specimens which had ever come under his observation. It is now lodged in the Society's Museum.

From the summit of Tooter Hill, which attains an elevation of 1,419 feet, a most extensive view of the surrounding country is obtained; with a clear and favourable state of the atmosphere the Irish sea is visible to the west, whilst the outlines of the highest summits of the Pennine chain, Whernside, Pen-y-ghent, Ingleborough, and Pendle Hill can be distinctly traced in the north, and to the east, and south-east, Blackstone Edge and the Yorkshire hills are seen succeeding each other in wave-like undulations until lost in the far horizon.

From its elevation and commanding position, Tooter Hill is a good stand point from which to study the effects of the several denuding and eroding forces which have operated in producing the form and configuration of the land surface which now prevails,—a subject which is at the present moment engrossing much of the attention of several of our eminent and leading geologists, and one which is provoking a most interesting and animated discussion. On descending the hill on its easterly side, a line of fault was passed over, near Temperley's brick yard, which was pointed out by the writer as trending N.W. and S.E., and as being a downthrow to the east of 90 or 100 yards, thus bringing in the rock in Clough Head Quarry at a considerably lower level than the Gorse Hall rock last described, although its true geological position is probably 30 or 40 yards superior. The dislocation here referred to is a most important one, and has produced a disturbing influence on the rate and direction of the dip over a considerable area; it has, in fact, resulted in the formation, along the crest of these hills, of a synclinal axis; for whilst we find the strata on the west dipping at a gentle inclination to the N.E., that on the east has a much more decided dip to the west, averaging from 8° to 10°. It is from this circumstance that the section in Dulesgate gorge is rendered one of the most interesting in the locality, by enabling the explorer to pass through a considerable thickness of strata in descending the ravine, the fall of which is almost as great as that of the strata, but in an opposite direction. Crossing the turnpike road, Clough Head

Quarry at Sharneyford was next visited. From here a fine, yellow, free sandstone is obtained, which possesses valuable properties as a building stone, being fine in texture, and capable of being worked with great facility into any form required. It is generally known to Lancashire geologists as the old Lawrence rock, and is considered to be the corresponding bed to the Catlow Lane Head rock near Burnley, and the Elland and Southowram flags of Yorkshire.

The Clough Head rock occupies geologically the highest position on the range of hills separating the valleys of the Irwell and the Calder, with the exception of about six or seven feet of finely laminated grit, principally used for roof tiling, which comes on about twenty feet above the first named rock; the interstratified layer being one of very black shale. This tile rock has for a long period been worked, on an extensive scale, along the hill side from Sharneyford to Heald; it is now, however, nearly exhausted, and is only quarried at one place at Sharneyford. A heavy shower of rain coming on at the time, prevented the quarry being visited.

On descending the hill a short distance, the Gorse Hall rock was again encountered at Culvert Coal pit, where it attains a very considerable thickness, probably not less than 100 feet; the false bedding was again here very marked. A portion of a large fossil trunk, probably the stem of a *Lepidodendron* was noticed embedded in a block of stone. The coal-pit tramway passes some distance through this rock, and then cuts through the fault, beyond which the Gannister coal is reached on its westerly, or up-throw side.

On reaching the Bay Horse Inn, in Dulesgate, the party was met by several gentlemen from Todmorden, amongst whom were Mr. Stansfield, the botanist, Mr. Chambers, Mr. Waugh, the Lancashire poet, and others. An excellent natural section of that portion of the coal-measures which had been passed through in descending from the hill top to this point, is well exposed, immediately in rear of the Bay Horse Inn, in a deep narrow gorge on the

hill side, where the several beds of coal, with their intercalated strata, are seen succeeding each other in regular order, in position corresponding with that previously noticed in the ascending scale from Bacup to Sharneyford, with the exception of the Higher-foot coal, which is absent from this section,—the reason for which has been previously given, and need not be repeated.

On returning to the road after having examined the last described section, the Woodhead Hill rock was passed on the left hand. A little further on the Rough rock and Feather Edge coal crop out, near the road side, at Bank's Mill. The representative of the Lower flag rock was seen in the brook, just below the Rough rock; it is here very thin, and poor in quality, having undergone a complete change in character from the Rossendale flags, in the distance of a few miles.

A thick bed of shale was next passed over, near the bottom of which, and across the brook from Clough Bottom School, a thin seam of coal was pointed out, probably one of the Brooksbottom series. A most persevering search failed to reveal any trace of fossil remains in the shale overlying the coal, although it was stated fossils had been found in other situations over coal identical to this.

A short distance below Clough Bottom, on the left hand side of the road, an excellent road metal is obtained; the stone is hard, grey, and fine in texture, full of cracks and joints, causing it to split and break up into small irregular pieces. This, Mr. Binney stated, was the equivalent of the Pease Pudding rock, which has been worked for the same purpose near Holcombe, and other places. The time being considerably advanced, did not permit of the company visiting the quarry. About 100 yards further on, a thin seam of coal was noticed cropping out on the side of the road in the midst of a bed of shale.

A thick mass of coarse grit was next met with, rising on both

sides of the road into bold rugged precipices, where the valley is contracted into a narrow picturesque gorge or pass, leaving barely space for the passage of the road and river. This grit is by some considered as the highest member of the millstone grit series, and consequently as the line of separation between that formation and the lower coal-measures. Others take the last described rock as the dividing line, whilst the Geological Survey remove it still higher and take the Rough rock as the base of the coal-measures.

A fault was observed behind the cottages on the road side near the mill lately occupied by Messrs. Ormerod and Brothers, which appeared to cross the Dulesgate valley in a diagonal direction, trending N.W. and S.E. This fault, like the one last described, is a downthrow to the east, bringing in again the massive grit (referred to above,) at a lower level, opposite Messrs. Ormerod's mill, where it is found lying in an almost horizontal position, whilst, as previously stated, the general dip of the strata passed through since crossing the Sharneyford fault, has an average declination to the west of 8° to 10°. A thick mass of dark shales, having two or three inconsiderable beds of grit, and three or four seams of coal, varying from 6 to 12 inches in thickness, distributed through it, succeeded the rock last alluded to, and occupied both sides of the road to near Gauxholme, where a thick massive bed of coarse sandstone, abutting upon and overhanging the road, was met with, having a dip of about 35° west. This marked and considerable deviation from the almost level position of the strata lying between Ormerod's mill and the Gauxholme rock, probably owes its origin to the occurrence of a fault somewhere near the point of contact of the shales and rock, although no trace of it was detected by any of the party in passing over it.

In a layer of shale about four feet above, a thin bed of coal exposed on the road-side opposite Messrs. Fielden's Mill, several of

the company succeeded in finding specimens of a small spiral shell, (probably *Melania*) the search for which was most perseveringly continued for some time by some of the most enterprising geologists.

After a careful search, extending over a period of two or three years, this shale has yielded to the writer five or six species of *Univalves*, a *Lingula*, a palatal tooth of *Ptychodus*, some fragmentary fish scales, and a substance having much the appearance of *Coprolites*. The investigation was continued by the party along the canal bank to Todmorden, and the various beds of rock and shale, as they cropped out along the side of the railway, from that place to the railway station, were observed.

Dinner having been provided, and the party augmented by the addition of several members and friends of the Society, assembled at the White Hart Hotel, when thirty-two sat down to an excellent dinner, presided over by Mr. Binney, who proposed, in appropriate terms, the usual loyal and patriotic toasts, together with others having more immediate reference to the proceedings of the day, and the objects sought to be attained by this and kindred Societies.

The weather was somewhat unpropitious, several heavy showers of rain having fallen during the day,—not, however, to such an extent as to cause any serious inconvenience to the excursionists; the little discomfort occasioned thereby was borne with the greatest good humour and cheerfulness by all present.

This most agreeable and successful day's proceedings were brought to a close by a vote of thanks to the Chairman, after which the company separated.

The thanks of the Society were given to Mr. Aitken for his valuable and interesting paper.

A discussion ensued, when—

Mr. Edward Hull, F.G.S., of the Government Geological Survey, said he had listened with great pleasure to Mr. Aitken's very lucid description of that excursion in which he (Mr. Hull) was not present. It would almost do for one of the Geologic al Memoirs of that district when they came to be written. In the descripti on of the scenery, reference was made to "the points" in the Pennine Chain. Strictly speaking he did not think there were such things as points, he thought "summit," or some similar term, would more strictly express the exceedingly flattened appearance of the highest portion of that Chain. With regard to those rocks observed in going down the valley of Dulesgate, they had been to him a great puzzle for a long time, but he flattered himself that he now thoroughly understood their position in the geological scale. This was only after a very minute and careful tracing of their upper and lower boundaries, and of the faults which affected the vale of Todmorden, from the southward up to Todmorden and the Portsmouth valley itself. He might almost defy any man going down that vale and examining those rugged and broken rocks on the side of the Todmorden valley, to arrive at a real knowledge of their true position with respect to each other, without doing what with him of course was merely his duty—tracing out each of these rocks one by one and step by step through all the district. With regard to those rocks which lie above the Rough Rock, they were all perfectly agreed, as also on the section down from the Rough Rock, to the base of those shales which lie below the Rough Rock and which sometimes included the Haslingden flags. At the base of these shales you come to a coal seam, which had been described, cropping out at the brook side, and a few feet below that, a bed of rock. This was the rock which they visited the other day above Plunge Mill Bridge,—not the first rock they saw at Stubbins,

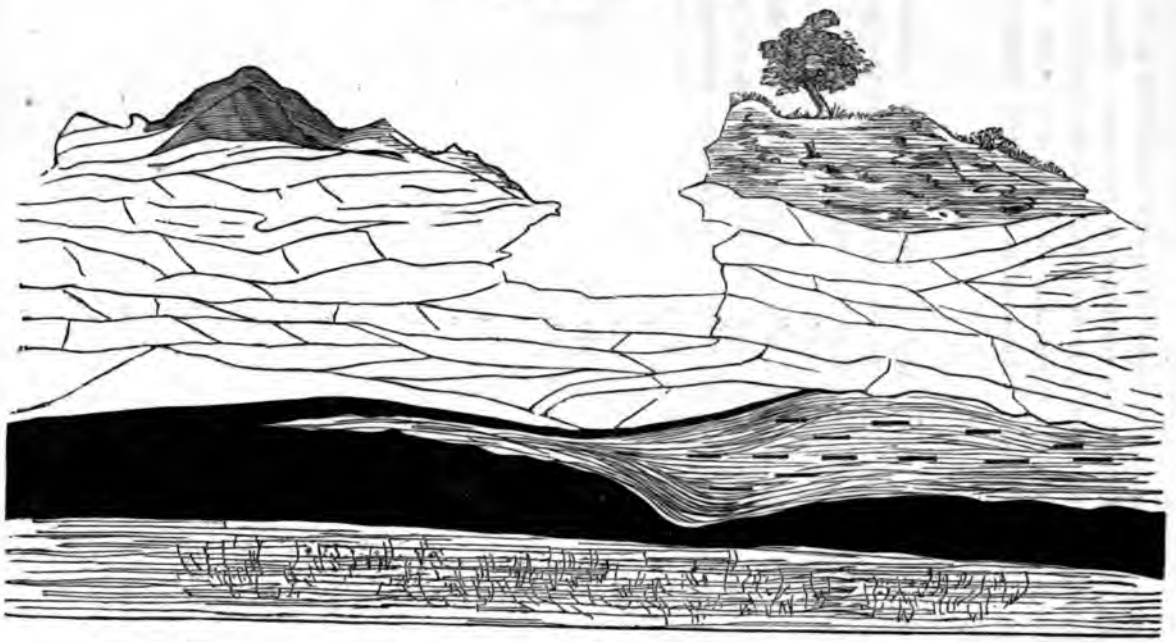
but the second rock, separated from it by the bed of shales. In their category of that series, the Geological Survey termed that "the third grit," reckoning downwards from the Rough Rock. Supposing that first bed to be the third grit—which in that district was divided into two beds—there were an upper and a lower third grit, and the lower third grit was that very coarse rock which they came to lower down, and which, where the valley was very steep and precipitate, was very well defined in the Dulesgate section. At the bottom of that you came to the "fault" described as crossing the road, and the effect of which was the downthrow of both those beds (third grits) which were thrown down and repeated again, so that you had the same succession twice over. You went on further still, and you came to another fault which he had seen in one part of the valley but which was not visible where the road crossed, and that brought in for the third time the Gauxholme Rock at the low end of the Dulesgate Valley, where it opened into the Todmorden Valley. It was the same as the massive rock higher up the hill—the lower bed of the third grit. He believed that this was the true geological position, and that the Gauxholme Rock was the same as the rock they visited behind Rose Bank Print Works, near Stubbins, at their last excursion, and which is also quarried at Fletcher Bank, above Ramsbottom.

In reply to a question from the President, Mr. Hull said he had not yet traced these rocks up as far as Pendle Hill, but in the same range, near Blackburn, they came out with great regularity. There were the Rough Rock, the Haslingden flags, then the two third grits, and at the base of the series, the Kinder Scout grit; each of these were separated by thick beds of shale.

The President remarked that for the last thirty years, in all their communications, these millstones had been an unknown quantity. They were never certain to six or eight hundred feet of their thickness. They had generally been lumped together as upper and lower millstone, divided by a great thickness of black and grey

SECTION OF THE GANNISTER COAL MINE,

OAKEN CLOUGH, BACUP.



shales. They took the rock that capped Pendle Hill as the lower millstone, and Mr. Hull's third grit as the upper millstone. He differed with Mr. Hull as to the position of the thick gritstone at Gauxholme. He considered it much lower down than the third grit. The thickness of these millstones varied considerably at different places.

Mr. Aitken briefly replied, and especially expressed his obligations to Mr. Hull, for the information which that gentleman had afforded in the most frank and cordial manner.

After a brief discussion on the peculiar formation of the section of the Gannister Coal Mine, mentioned in Mr. Aitken's paper, (a sketch of which he exhibited,) the proceedings terminated with a vote of thanks to the President.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 3.] VOL. VI. [Session 1866-67.

The Monthly Meeting of the Members of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, December 18th, 1866.

G. C. GREENWELL Esq., F.G.S., one of the Vice-Presidents, in the Chair.

The President read a paper on "The Upper Coal Measures of England and Scotland." On the walls were several diagrams which were referred to in illustration of the subject. The President remarked at the outset that he had been called upon rather in a hurry for his paper, and he had consequently been obliged to give less time than he liked to a very important subject. The following is the paper :—

ON THE UPPER COAL-MEASURES

OF ENGLAND AND SCOTLAND;

By E. W. Binney, F.R.S., &c.

At the present time much attention is directed to the duration of our coal fields, one party asserting that they will be speedily exhausted, whilst the other estimates that they will continue for thousands of years. Probably the advocates of both these views have not yet adduced sufficient proofs to establish their propositions to the satisfaction of themselves or their readers. The quantity of coal to be obtained will, in a great measure, depend on the price that can be paid for it. Although much has been done by the Geological Survey, and amateur geologists of late years, to investigate the Upper Coal-Measures and their overlying Permian and Triassic beds, it may safely be asserted that we do not yet know with certainty where the Carboniferous strata end and the Permian begin,—in fact, higher Carboniferous strata and lower Permian ones may yet be discovered than any with which we are now acquainted. In a paper printed by me some years since, on the Canobie Coal-Field,* evidence was given to shew the occurrence of two hundred yards of Upper Coal-Measures lying above the Spirorbis limestone, and these appeared to me to be some of the highest carboniferous strata that have been met with in Great Britain, although I could not positively prove their passage into the overlying Permian beds. This could not be done without a considerable expense in cutting through some yards of intervening strata. Undoubtedly this is one of the most likely places to find evidence of one formation passing into the other, for here we have probably some of the highest Carboniferous strata yet investigated, and although not the lowest Permian beds, still, portions of that formation undoubtedly

*Further Observations on the Carboniferous, Permian, and Triassic strata of Cumberland and Dumfries, ii. vol., Third Series, of the "Memoirs of the Literary and Philosophical Society of Manchester."

low down in the series. In the North Staffordshire coal-field, Mr. Ward, of Longton, has described a Spirorbis limestone lying thirty-six feet above the Bassey Mine coal and ironstone, and as low down in the Coal-Measures as 1080 feet according to Professor Warrington Smyth's section. Many years since, the similarity of the North Staffordshire coal-field, in its upper portion, to the same part of the Manchester coal-field, was evident to me not only from its ironstones and limestone, but also its organic remains. Probably in the present state of our knowledge we shall not be far wrong in assuming the two hundred yards of Coal-Measures found lying above the Spirorbis limestone, a little to the north of Canobie Bridge, to be the highest, until higher ones have been discovered, in Scotland, and the North Staffordshire ones the highest in England.

This limestone is seen best developed at Ardwick, near Manchester, and has been described by Professor W. C. Williamson, Sir R. I. Murchison, and myself, nearly thirty years since. The public is indebted to Mr. William Mellor, of Ardwick, for most of the information respecting it. Since the last published account new beds of limestone continue to be discovered in the upper parts, and more may yet be met with. By the kindness of Mr. Mellor I am enabled to give the following section, which is more complete than any yet published.

Section of the strata met with in sinking the Pumping Pit, on the hill-side, near the joiners' shop, Ardwick; supplied by Mr. Mellor:—

		Feet.	Inches.
Drift —	Till	36	0
	Sand and Gravel	1	6
	Red Clay (first stratified measure)	4	0
1st	Limestone, with clean open joints—makes little water	1	2
	Dark Clay Floor	0	8
	Red Clunchy Clay	10	0

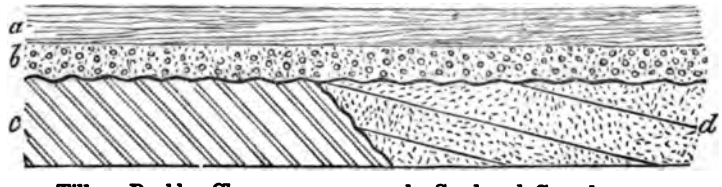
2nd	Limestone, with open joints	1	4
	Gray Clay Floor	0	6
	Clunchy Clay	11	0
3rd	Limestone	1	4
	Hard Red Clay	13	6
4th	Limestone	0	10
	Very Hard Red Clay	36	0
5th	Limestone	1	0
	Gray and Red Clays	24	0
6th	Limestone	2	0
	Clunchy Clay	23	0
	Band of Gritstone, with water	1	0
	Gritty Metal, with a little water	21	0
	Gray and Brown Clays	54	0
7th	Limestone	4	0
	Red and Green Argillaceous Beds	15	0
8th	Limestone	3	0
	Red and Green Clays	4	0
9th	Limestone (occasional)	1	0
	Clays and Shales, with Calcareous courses ...	15	0
10th	Limestone	1	6
	Shales and thin Grits	45	0
	*Coal and Blackband Ironstone (Bassey Mine)...	1	6
	Sandy Shale	6	0
11th	Limestone (Main or Great)...	9	0
	Red and Variegated Shales and Clays, with Bands of Ferruginous Limestone ...	60	0
	Coal	0	6
	Floor	6	0
	Large Calcareous Nodules	0	10
	Shales and Red Rock of Holt Town...	81	0
	Red Shales	15	0
12th	Limestone and Red Ironstone	2	0

From this last-named stratum down to the Four Feet Coal of Bradford, Pendleton, and Worsley, the base of the Upper Coal-Measures is a distance of 1200 feet, as proved by the Patricroft

* I have called this Bassey from its resemblance to the North Staffordshire ironstone of that name.

sinking, containing eighteen seams, some of which have been wrought.

Since the time Sir R. I. Murchison published his section of the Ardwick Limestones, in 1839,* Mr. Mellor has discovered six superior beds, and 243 feet 10 inches of Coal-Measures in sinking the new pit previously named, and in all probability there are higher measures still. By the kindness of that gentleman, who drove a tunnel on the dip, I was enabled to see the highest strata given in the section. These beds dipped 20° south of west, at an angle of 18° and were covered on their dip by a soft red sandstone without pebbles, which dipped in the same direction as the carboniferous strata but at a less angle, probably about 10°. There was no trace of a passage of one formation into the other, but, on the contrary, there was as sharp and marked a line of boundary betwixt one and the other, as in the overlying drift. The Coal-Measures, (red and purple shales) both on their upper surface where covered with drift, and on their dip where covered by red sandstone, had eroded and water-worn surfaces. These were strewn with weathered pieces of Spirorbis limestone, and shewed clearly that a denudation of these Upper Coal-Measures had taken place prior to the deposition of the red sandstone, which appears to me to be the lower soft red—the lowest member of the Bunter division—on its eroded surface,† (as shewn in the accompanying wood cut.) What higher Carbon-



a Till or Boulder Clay. *b* Sand and Gravel.
c Upper Coal-Measures. *d* Lower Soft Sandstone (Bunter.)

*Silurian System, page 87.

†On the Geological Survey map of the district, this sandstone is coloured as Permian. I first took it to be such, but the bore holes on the dip, at Messrs. Gallimore's, Hoyle's, and other places, prove the Permian Marls to underlie it.

iferous strata may yet be met with no one can tell, but if all the measures which occur in the North Staffordshire are there, several hundred feet of strata have to be found before we have a chance of seeing the Carboniferous strata passing into the overlying Permian strata in the neighbourhood of Manchester, even if they do so pass.

In all the beds of limestone, the *Spirorbis Carbonarius* is found generally associated with a small *Leperditia*. The blackband ironstone found with the highest bed of coal is full of the *Anthracomya, Phillipsii*, and numerous teeth, scales, bones, and rays of fishes. In a bed of purple shale lying about sixty feet above the main limestone, are numerous remains of plants, amongst which are the following: —*Pecopteris abbreviata, P. Serlii, Odontopteris, Dictyopteris, Poacites, Cyclopteris flabellata, Neuropteris cordata, Sphenopteris irregularis, S. coralloides, Asterophyllites longifolia, Aphyllostachys? Calamites Suckowii, C. cannæformis, Sigillaria elegans, Lepidodendron Sternbergii, Lepidophyllum, Trigonocarpon, Lepidostrobus variabilis, L. comosus, L. ornatus, Lycopodites*, &c.—Among those plants, Mr. Salter thinks he has detected the remains of an Orthopterous insect.

In the limestones, shales and blackband ironstone: Shells—*Anthracomya, Phillipsii, Anthracoptera, Browniana*, (Salter): Crustacea,—*Leperditia inflata*, and *Leaia Leidyi var. Williamsonia*. Fishes—*Megalichthys, Rhizodus, Rhizodopsis, Palæoniscus, Platysomus, Cœlacanthus, Gyracanthus, Ctenacanthus, Orthacanthus, Pleuracanthus, Diplodus, Ctenoptychius, Ctenodus, Ceratodus*, and remains of reptiles not yet described.*

Sir R. I. Murchison was the first geologist to point out the value of this Upper Coal-Field, in his Silurian System, and he described the Lebotwood, Pontesbury, Uffington, Westbury, and Tasley near

* Professor W. C. Williamson, F R.S., nearly thirty years since, recognized the reptilian character of bones from this locality.

Broseley beds, and compared and identified them with similar strata at Ardwick. He at first supposed that they were of fresh-water origin, and he imagined that he had traced them gradually passing into the overlying Lower Red Sandstone of the Permian formation. Both these conclusions are now much doubted, and require to be supported by more facts than have yet been adduced in their favour.

Mr. Howell has carefully described the Spirorbis limestone in the Nuneaton coal-field, but he does not say that he found its overlying carboniferous strata passing upwards without a break into the Permian beds. At page 26 of his Memoir on the Geology of the Warwickshire Coal-field, and the Permian Rocks and Trias of the surrounding district, he says, "In the higher part of the coal-meas-"ures of this coal-field, as already described, there is a thin bed of "limestone which generally occupies a position about fifty feet below "the lowest bed of the Permian rocks. It is generally from two to "three feet thick, and contains the small serpula *Spirorbis Carbonarius*, "and it is locally known and erroneously called 'fresh-water lime-"stone.' It is seldom seen *in situ*, although from the numerous old "workings the position of its outcrop is well defined." The same author, at page 30, says, "The Permian rocks occupy a very consider-"able tract of country in this district, and are of very great thickness, "resting directly on the coal-measures, and, as a rule, being con-"formable to them." Their thickness is not less than 2,000 feet, and they consist of alternations of pale, red, brown, and purple sandstones, and red marl, with beds of calcareous, breccia, and conglomerate.

By the kindness of Mr. Edwin Baugh, of Bewdley, evidence has been afforded me of the occurrence of this limestone at Prizeley, and Gibhouse, near Cleobury Mortimer, in the Forest of Wyre. Mr. Ward, of Longton, has given me specimens from the North Staffordshire coal-field, at Longton. In many of the Permian, breccias, and conglomerates found near the coal-fields of Salop and

the adjoining counties—more especially at Alberbury it is met with—and in similar beds at Westhouse, near Kirkby Stephen, it has been seen by me.

In memoirs published by me,* the limestone *in situ* has been described as occurring at Whiston, on the Manchester and Liverpool Railway; at Raw Beck, near Carlisle; at Canobie, on the Esk; in Dumfrieshire; and at Ballochmyle, near Catrine, in Ayrshire.† So, from the Forest of Wyre to the last-named place in our western coal-fields, it has been met with more or less over a distance of 300 miles.

A few sections will be given to shew the position of the Spirorbis limestone in different coal-fields, and its distance from workable seams of coal, but before doing so it will be desirable to present them in a tabular form.

PONTESFORD SECTION.‡

	Feet.	Inches.
Red and Variegated Shales, Sandstones, and Clods ...	90	0
COAL	1	6
Variegated Shale	6	0
Sandstone (used for building purposes)	27	0
Stiff Shale	6	0
White Shale	12	0
Mixed Shale	6	0
Limestone, (in two beds)	7	0
White Sandstone	33	0
Coal Smut	3	0
Shale	6	0
YARD COAL	3	0
Shale	54	0
COAL	1	4

* Memoirs of the Literary and Philosophical Society of Manchester, vol. xii., page 36; vol. ii., (third series,) page 367.

† Geological Journal, vol. xviii., page 437.

‡ Murchison's Silurian System, page 83.

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Coal Smut	3	0
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YARD COAL	3	0
Shale	54	0
COAL	1	4

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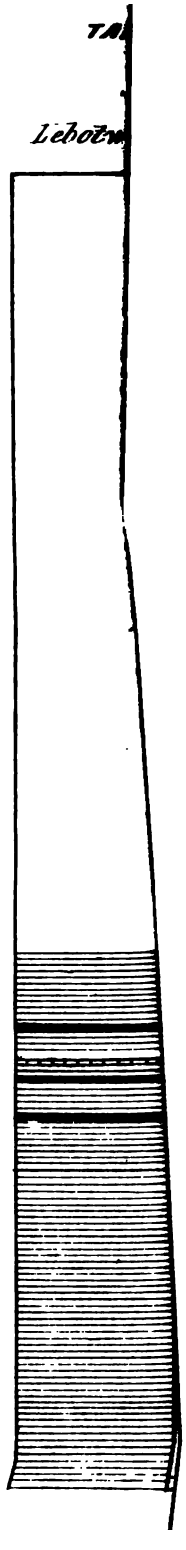
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Uffington Section.*

	Feet.	Inches.
Drift	42	0
Red and Variegated Sandstones and Shales	65	0
Coal	0	6
Sandstones and Shales	38	0
Limestone	3	0
Shales	36	0
Coal	3	0

Wellbatch Section.

Coal-Measures	90	0
Coal	1	6
Measures	40	0
Coal	0	4
Measures	15	0
Coal	0	2
Measures	26	0
Coal	0	1
Measures	30	0
Coal (Halt-Yard)	1	6
Measures	60	0
Limestone	4	0
Measures	50	0
Coal (Yard)	3	0
Measures	58	0
Coal (Thin)	1	3

Lebotwood Section.

Coal-Measures (thickness not given)	0	0
Coal (Half-Yard)	1	6
Measures	60	0
Limestone	5	0
Coal (Yard)	3	0
Measures	46	0
Coal	1	0

* Ibid., 92.

Tasley, near Broseley.

	Feet.	Inches.
Green and Yellow Shale	6	0
Limestone	3	0
Shales	9	0
Coal (Impure)	0	6
Shale	0	2
Coal	1	4

Baxterley Section.

Shales and Sandstones	50	0
Limestone	2	6
Gritstones and Shales, containing four thin seams of coal	530	0
Coal (*Four Feet*)	4	4

Fenton Section.*

Red and variegated shales, and clays with fine and coarse gritstones and beds of green earth and volcanic ash, contain thin seams of coal and remains of coal plants, about	700	0
Clay	16	0
White Shale	27	0

* The highest strata have been added by me as well as those under the upper limestone; but the remainder of the section was kindly furnished by Mr. Ward, from a sinking at Messrs. Sparrow's. At some places, as at Silverdale, according to Mr. Ward, the following strata occur above the Red Shag Ironstone:—

	Feet.	Inches.
Top Red Mine Ironstone	1	6
Shale	115	0
Blackband Ironstone	3	0
Coal	2	9
Shale	30	0
Red Shag Ironstone	5	0
Coal	2	0
Shales and Rock	42	0
Lower Red Mine Ironstone	5	0
Coal	2	0
Rock	5	0
Shale	11	0
Little Coal	0	6
Parting of Black Bat	1	6

	Feet.	Inches.
Coal	1	0
Shale	10	0
Rock	3	0
Little Coal	0	6
Shale	19	0
Little Coal	3	0
Shale	12	0
Little Coal	0	9
White Shale	18	0
Shale, mixed with rock balls	12	0
Red Shale	10	0
Gutter Coal	1	8
Shale	14	0
Coal	0	8
Dark Shale	9	0
Strong White Shale	15	0
Dark Soft Shale	10	0
Strong White Shale	18	0
Two Coals, with Partings	10	0
Shale	10	0
Red Shale	9	0
Strong White Shale	11	0
Dark Shale	15	0
Rock	10	0
Shale	9	0
Little Coal	1	0
Shale	27	0
Red Shag Coal	1	8
Strong Shale	27	0
Limestone	2	0
Shale	45	0
Lower Red Mine Ironstone	5	0
Coal	2	0
Shales and Gritstones with thin coals	144	0
Limestone	2	0
Coal-Measures	36	0
Bassey Mine Ironstone	4	0

Silurian System, page 100.
Memoirs of the Geological Survey of Great Britain.
Warwickshire Coal-Field, by H. H. Howell, F.G.S., page 26, section No. 9.

Whiston Section.

	Feet.	Inches.
Red Sandstone, and red, green, & variegated shales, about	15	0
Limestone	3	0
Red Shales, with thin gritstones, about	80	0

Raw Beck Section.

Red and Variegated Shales	39	0
Limestone	1	0
Red Sandstones and Shales, with coal plants, but no seams of coal seen, about	900	0

Canobie Section.

Red and Variegated Sandstones and Shales, containing coal plants	600	0
Limestone	0	6
Great unascertained thickness of upper Coal-Measures, probably as thick as those of Catrine ...		

Catrine Section.

Purple and Variegated Sandstones and Shales	48	0
Limestone	0	10
Coal-Measures, in which no profitable seams have been yet met with, about	2000	0

All these sections shew but one bed of Spirorbis limestone, except that at Manchester, previously given, which has twelve, and the North Staffordshire section which has two, and probably will on careful examination, afford more, as there the upper coal-field is so well exposed, that we should expect to find more beds of limestone than two. Mr. Ward informs me that at Fenton two beds of limestone were found in sinking one of Messrs. Sparrow's pits, and these beds were parted by nine yards of shale. This sinking was 500 to 600 yards to the east of the pit where the section before given was found; so it apppears that the upper limestone divides towards the east in that district, or else two separate beds occur there, thus making three altogether.

The great extent of country in the coal strata, where the Spirorbis limestone is found, on the western side of England and Scotland, shews it to have originated from a widely extended deposition of carbonate of lime at a late period—near the close of the Carboniferous epoch; and it appears to have been deposited to a much greater extent in the Manchester district than in any other place herein named, and during a longer period of time. The occurrence of the *Spirorbis Carbonarius*, which is well-known as being found in Carboniferous rocks of all ages, from the Burdiehouse limestone up to the Ardwick beds, would have little value for identifying strata at distances of 200 and 300 miles apart, by itself. It was formerly attempted, by one of the most eminent of living geologists, to prove that the Burdiehouse limestone occupied a position above the Millstone Grit, simply because it contained the Spirorbis and some other common coal fossils. Now the diagnostic value of such fossils has greatly diminished at the present day; but in addition to the occurrence of the Spirorbis, this limestone on breaking exhibits a singular porcelain-like appearance, a conchoidal fracture, and a mottled character, which are not recognized in other carboniferous limestones so far as my experience goes; and it is always found in the upper part of the Coal-Measures near to Permian beds, and generally makes a good hydraulic lime. In addition, it is always, so far as my observation extends, associated with purple and greenish-coloured shales, and fire clays, as well as green earth, and what has sometimes the appearance of volcanic ash. Altogether the general appearance of these strata, independently of the occurrence of the Spirorbis limestone in them, give evidence of Coal-Measures very different in appearance from what we are accustomed to find in the middle and thick parts of the Scotch and English fields.

On the Permian and Triassic Strata of the north-west of England and the west of Scotland.

After working many years on the Permian Strata of the north-

west of England, and publishing numerous papers on the subject, it appears but little of that information has reached not merely the public, but even some eminent mining engineers.* In the vicinity of Manchester the red clays with Magnesian limestones, which most probably are the representatives of the Lower Magnesian limestone of Durham and Yorkshire, vary in thickness from 130 to 300 feet, and contain from four to twelve beds of limestone; and the underlying conglomerate from one to fifty feet. At Astley fifty-four thin beds of limestone were met with in a bore hole, and about thirty in a sinking. All these beds contain Magnesia in their composition, and are full of fossil shells characteristic of the Magnesian limestones of Yorkshire and Durham.

In order to give some idea of the thickness and variability of these deposits, it is desirable to put them into a tabular form:—Any treatise on Upper Coal-Measures would be incomplete without some description of these important strata.

* In vol. xv. of the Transactions of the North of England Institute of Mining Engineers, page 16, on the discussion of Mr. Joseph Dickinson's paper on some of the leading features of the Lancashire Coal-Field, occurs the following:—

"Mr. Boyd.—I was going to ask Mr. Dickinson to give us the appearance of the Magnesian limestone. Does it appear at all? In all our county it underlies the New Red Sandstone."

"Mr. J. Dickinson.—I think there is no trace whatever of the Magnesian limestone. If it be, it is so thin as to be scarcely worth noticing. Mr. Binney, of Manchester, who has devoted a great deal of attention to the Permian Strata, thinks he can trace a little of it about a foot in thickness. He has shown it to to me; but generally you may say the Magnesian limestone does not appear here." * * *

"The Chairman—How do the geologists of this district classify the New Red Sandstone? They take the Trias as the upper portion, then immediately below that the Permian.—But have you any of the great conglomerate?"

"Mr. J. Dickinson—The thin bed, one foot thick, which I have spoken of, called Magnesian limestone, appears to me to be a sort of conglomerate; but I do not put myself forward as an authority on this matter. For anything we know yet, the coal-field is extending under the New Red Sandstone."

Tabular view of the Permian strata of the north-west of England and the south-west of Scotland, as seen near Manchester; at Westhouse, near Kirkby Lonsdale; Shawk, near Carlisle; Barrowmouth, near Whitehaven; Moat and Canobie, near Longtown; and near Catrine, in Ayrshire; in the descending order, and with approximate thicknesses :—*

	Manchester.	Westhouse.	Shawk.	Barrowmouth.	Moat.	Catrine.
	feet.	feet.	feet.	feet.	feet.	
1. Laminated and fine-grained red sandstones (St. Bees).	Not seen.	Not seen.	300	1000	30	Not seen
2. Red and variegated clays or marls containing sometimes, but not always, beds of limestone and gypsum, and bands of sandstone, the clays and limestones containing fossil shells of the genera *Schizodus*, *Gervillia*, &c.	300	Traces of them seen.	150	70	225	Not seen
3. Conglomerate or breccia.	50	300	4	3	600	300 †
4. Lower Red Sandstone, generally soft and incoherent, (Upper Rothliegende).	500	500	7	Not seen		
5. Red shaly clays.	Not seen	250	Not seen	Not seen	Not seen	Not seen
6. Whitehaven and Astley pebble-beds containing common coal plants, but quite unconformable to the Upper Coal-Measures and the Upper Permians, & termed by me Lower Permian, (Lower Rothliegende)	60	Not seen	Not seen	140	Not seen	Not seen

* The first four strata of the above series, Professor Harkness, F.R.S., in a fine natural section seen at Hilton Beck, near Brough, estimates to be fully 3000 feet in thickness. He also states that he has found the marl-slate there, with its characteristic fossils.

† Mr. Gekie, F.R.S., in vol. iii., No. 6, June, 1866, of the Geological Magazine, has lately shewn that the so-called breccia, at Ballochmyle, near Catrine, is more like trap tuff and ash than a true breccia. From my own observations I quite agree with his view, having noticed the ashy appearance of some of the lower beds when I last saw them. Volcanic ash will probably be found in the cement-

At Whitehaven the lower portions of the sandstone are quite of a conglomerate character, and contain many white quartz pebbles and one large slate pebble (6 inches in diameter), as well as a considerable quantity of peroxide of iron and decomposed felspar, which appeared to me like volcanic ash. The dips of the sandstone and the Coal-Measures appeared to be about the same; but, so far as my observation went, there was no appearance of the passage of one rock into the other, but only a simple superposition. The lower portions of this sandstone are exactly of the same character as the sandstones of Astley and Bedford, described by me as Lower Permian, and in no wise to be distinguished from a similar coarse sandstone (containing coal-plants) seen in the Ballast-quarry at Moira, near Ashby-de-la-Zouch, which Mr. Woodhouse and other practical geologists of the neighbourhood consider to be quite unconformable to the underlying coal-field. It also resembles the Allesley sandstone found near Coventry, in which the remarkable fossil woods, now in the Warwick Museum, were found. No one can distinguish the silicified woods of Moira from those of Allesley. This rock, if not to be classed as Permian, must be taken as Upper and unconformable Coal-Measures; for in Lancashire and Leicestershire it is quite unconformable both to Permian strata above and Coal-Measures underneath. The chief reason which has induced me to remove it from the carboniferous strata is the conglomerate character of the lower part of the sandstone, which, as previously stated, is more like a Millstone-Grit than an Upper Coal-Measure rock. For the present it appears to me desirable to retain it, as Professor Sedgwick first designated it, by the name of Lower Red Sandstone, or my name of Lower Permian. It is to be remarked, that when the soft sandstone of Collyhurst, Kirkby

ing paste of many of the breccias and conglomerates of the S.W. of Scotland, and the N.W. of England, as well as in the Whitehaven, Astley, and Moira sandstones, and some of the upper Coal-Measures, when they come to be more carefully examined. On shewing some of the specimens of trap to Professor Geinitz, of Dresden, a few years since, he at once said that they were of Permian age.

Stephen, and Hilton is absent, this sandstone is generally met with; and, so far as my knowledge extends, it has not yet been found at a distance from profitable coal-fields. It is absent in all the Permian sections that I have seen in Yorkshire, Westmoreland, and Cumberland, from Westhouse to Penton and Canobie.

The passage of the Whitehaven sandstone into overlying strata cannot be seen, as it appears to have been much denuded prior to the deposition of the conglomerate on its eroded surface. At Astley and Bedford, as well as at Moira, we find no shaly beds above this sandstone; so, if the Knotty Holm, at Canobie, sandstone should be proved to be of the same age as those strata, the beds lying between it and Canobie Bridge are deposits which have not yet been described in any other section in England.

As previously stated, when the Whitehaven sandstone is present a profitable coal-field is generally found near it. Now, in the Permian sections at Westhouse, as well as those of Kirkby Stephen, Belah, Brough, Hilton, and numerous ones about Dumfries and near Moffat in Scotland, the breccias or conglomerate beds and the lower soft red sandstone are well exposed, but we see no trace of the Whitehaven sandstone under those beds; so, on the whole, that rock appears to be more nearly connected with the Carboniferous than the Permian group in these districts away from profitable coal-fields. The plants are generally in a fragmentary condition, and present the appearance of having been drifted; so it is possible they may have grown during the carboniferous epoch and been drifted into the troubled waters in which the sandstone was formed. When, however, we observe it in Lancashire and Leicestershire, it is quite unconformable to the underlying Coal-Measures, and appears to have resulted from the movements of the earth's crust which followed on the elevation of the Coal-Measures, as supposed by Professor Sedgwick in his paper on the Whitehaven Coal-Fields.*

* Transactions of the Geological Society of London, (second series,) vol. iv., page 58.

With respect to the Triassic beds, so far as yet examined in Cumberland, they appear to differ from the typical beds seen in Cheshire and South Lancashire as to their divisions where Mr. Hull divides the Trias as follows*:—

Formation.	Subformation.	Thickness.
		feet.
Keuper	Red Marl	3000
	Lower Keuper Sandstone	450
Bunter	Upper Mottled Sandstone	700
	Pebble-beds	800
	Lower Mottled Sandstone	800
		5750

In the soft, red, variegated, and false bedded sandstones of Longtown, Rockcliffe, Holmhead, and Dalston, near Carlisle, we have a rock which would correspond with the lower or upper mottled sandstone of that author, but as yet nothing has been seen of the pebble beds. The Triassic beds in this district appear to have been deposited under circumstances of great quietude, very different from those in which the Permian beds were formed. The two divisions of the Keuper are there well developed in the water-stones, and red and variegated marls containing beds of gypsum, but, so far as yet known, without affording beds of salt, although it is possible they may be there. The red marls, most probably, pass upwards into the Lias at Quarry Gill and Oughterby, but there is no section showing the passage of the one into the other.

* On the new sub-division of the Triassic rocks of the central counties, by E. Hull, A.B., F.G.S. Transactions of the Manchester Geological Society, vol. ii, page 22.

Permian Strata of the north-east of England.

Mr. Kirkby gives the following thickness of the Permian Strata, in Durham and South Yorkshire :—*

SUBDIVISIONS.	DURHAM.	Feet.	SOUTH YORKSHIRE.	Feet.
1.—Bunter Schiefer ...	*Red Sandstone* overlying Magnesian Limestone in the S.E. portion of the County (Howse). Thickness.....	50 ?	Red Sandstone and Marl, near Doncaster and Tickhill—Geological Surv. Thickness.....	50 ?
2.—Upper Limestone...	*Yellow, Concretionary,* and *Crystalline Limestone, Limestone* of Marsden, Fullwell, Roker, Hartlepool, &c. Thickness.....	250	*Brotherton Limestone* and *Lower Red Marl,* and *Gypsum,* of Brotherton, Knottingley, Womersley, Wadworth, Tickhill, &c. Thickness.....	120
3—Middle Limestone...	*Shell* and *Cellular Limestone* of Tunstall and Humbleton Hills, Ryhope, Galley's Gill, Downhill, Claxheugh, &c. Thickness.....	150	Small-grained Dolomite, of Vale of Went, Lound Hill, Cusworth, Levit Hagg, Roche Abbey, Warmsworth, &c. Thickness.....	200
4.—Lower Limestone..	*Compact Limestone* of Pallion, Whitley, Pensher, Houghton-le-Spring, Ferry Hill, Thickley, &c Thickness.....	200	Lower Limestone, of Pontefract, Wentbridge, Hampole, Emsall, Brodsworth, Conisborough, Micklebring, &c. Thickness.....	120
5.—Kupfer Schiefer ...	*Marl Slate* of Claxheugh, Downhill, Midderidge, Ferry Hill, &c. Thickness.....	10		
6.—Rothliegendes	Lower Red and Yellow Sandstone of Tynemouth, Claxheugh, Hylton Castle, &c. Thickness.....	100	Lower Red, Yellow, and Variegated Sandstone, of Pontefract, Hickleton, Cadeby, &c. Thickness.....	100
Total Thickness		760		590

* On the Permian Rocks of South Yorkshire, and on the Palæontological relations, by J. W. Kirkby, Esq., Quarterly Journal of the Geological Society vol. xvii. page 287.

THE TRIASSIC STRATA OF THE NORTH-EAST OF ENGLAND.

These have not been accurately measured and described in detail, but they cannot be estimated at much less than from 2,000 to 2,500 feet in thickness.

THE PERMIAN AND TRIASSIC STRATA OF THE MIDLAND AND SOUTH-WESTERN COUNTIES OF ENGLAND AND WALES.

These deposits are very variable in their occurrence and thickness, and cover such an extent of country that the limits of this paper would not allow me to give the published sections of the Geological Surveyors, and other authors. Mr. Howell gives the Permian strata at 2,000 feet; and the thickness of the Triassic strata, in Warwickshire, as under:—*

	Feet.
Red and Mottled Marls and Keuper Sandstones	660
Lower Keuper or Waterstones	200
Upper Red and Mottled Sandstone	200
Conglomerate or Pebble Beds	450

But in some places, as at Bedworth, all the Triassic beds disappear, with the exception of the Upper Keuper, which rest directly on the Permians and Coal-Measures.

Mr. Hull, F.G.S., in his Coal-Fields of Great Britain, at page 115, gives the Permian beds of North Staffordshire—consisting of red and purple sandstone, marl, and cornstone, (with plants) strata slightly unconformable to the Coal-Measures—at 600 feet.

ON THE ENGLISH AND SCOTCH COAL FIELDS.

TheCoal-Measures of England and Scotland, from south to north, vary very much in their productiveness. In the former there is

* Mr. Howell's Memoir, previously quoted, page 35 to 45,

little or no coal so far down in the series as the Millstone Grit; while the upper measures—as previously shewn in this paper—contain several workable seams of coal, near to the Spirorbis limestone: especially to the south of Manchester. In the latter many productive seams of coal are found under the Mountain Limestone, and above the Old Red Sandstone; but in the Ayrshire coal-field, where the Spirorbis limestone has been found, there are 2,000 to 2,500 feet of Coal-Measures, in which no coal seam has been met with, although carboniferous plants occur. This variation in the productiveness of the Upper Coal-Measures, is of the utmost importance in all attempts to sink for coal through overlying Permian or Triassic strata, as will be evident to persons who are even slightly acquainted with the subject. It is quite difficult and expensive enough to sink through the Permian strata in many cases, without having to traverse a great thickness of barren Coal-Measures containing no seams of coal worth working. Therefore, in all attempts to explore for coal, in Permian and Triassic districts, the greatest care should be devoted to considering the age, position, and dip of the nearest wrought seams; and where the lower soft sandstone occurs, in many cases, it will be more advisable to follow the coals by inclines on the dip, than run the risk of tapping the sandstone, by sinking a shaft through it. While in the eastern coal-fields of England, from Ashby-de-la-Zouch, through Derbyshire, Nottinghamshire, Yorkshire, Durham, and Northumberland, and the Scottish fields of the Lothians and Fifeshire, as well as those of West Cumberland, North and South Wales, Clee Hills, The Forest of Dean, Gloucestershire, and Somersetshire, as far as my knowledge extends there has been no evidence yet found of the occurrence of the Spirorbis limestone; so in none of these districts, probably, is the series of Coal-Measures, as at present exposed, so complete as to shew the Upper Coal-Measures found in the west side of England and Scotland, and other places named in this communication. On comparing the Lower and Middle Coal-Measures of the west with those in the east, they agree perfectly well. It is only when we come to consider the Upper Coal-Measures containing the Spirorbis limestone, that we

find any difficulty, and then we discover from 2,500 to 3,000 feet of strata wanting, or not exposed, the Permian and Triassic strata probably covering them up; or their absence may be accounted for by the Upper Coal-Measures being unconformable to the Middle Coal-Measures.

The Upper Coal-Measures described in this communication, as previously stated, have not been yet met with in the eastern coal-fields of England and Scotland, and the other places above-named. It is yet to be seen whether sinkings through Permian and Triassic strata will prove their occurrence, covered up under those deposits. In the western coal-fields of Scotland, it is of great importance to ascertain the exact thickness of these Coal-Measures as yet supposed to be barren of productive seams of coal, although between 2,000 and 2,500 feet in thickness, before any attempts are made to search for coal under them. In the vicinity of Manchester, at some future time, when the price of coal will warrant it, a considerable extent of Upper Coal-seams will probably be wrought under the Permian and also under the Triassic beds. However, it is in the Staffordshire, Shropshire, Warwickshire, and Worcestershire coal-fields, where the seams are thicker and more valuable, and these Upper Coal-Measures are not so thick, that coals are most likely to be wrought, at the present price of coal, and in our day. There, new coal-fields are frequently being found under the Permian and Triassic strata, and everything tends to prove that these coal-fields are parts of one great coal-field, covered up by those deposits; and, that they are, or have been connected with the Gloucestershire, Forest of Dean, Somersetshire, and South Wales coal-fields on the south, and the Leicestershire, Derbyshire, Nottinghamshire, Yorkshire, Durham, Northumberland, Cumberland, Lancashire, Cheshire, North Wales, and the east and west Scotch fields on the north.

It has been for some years pretty well-known to geologists and practical colliers, that the coals are in no wise deteriorated by passing under the Permian or Triassic formations; and that they

exist under those deposits, if they can only be reached. No general rule can be laid down to guide parties in the search for coal under them, except a careful examination of the nature and thickness of the Permian and Triassic beds, and the age and position of the neighbouring Coal-Measures. Of all the difficulties the miner has to dread, the most formidable is the Lower New Red Sandstone, a soft, incoherent sand, that holds water like a sponge, and in the neighbourhood of Manchester sometimes reaching near 600 feet in thickness. The only favourable feature of this deposit is its uncertain occurrence under the Upper Permian and Trias. At Heaton Mersey, near Stockport, it is probably full 600 feet in thickness, and at Norbury Mill, some three miles distant to the south, it is not six feet.

In Scotland, I am not aware that the Permian or Triassic strata, if any of the latter have yet been found in the south part of the country, have been gone through in searching for coal; but at Patricroft, near Manchester, Mr. John Lancaster, F.G.S., and his brothers, reached the Four-feet Coal, the lowest part of the Upper Coal-Measures, at a depth of 440 yards; and the same gentleman found the Yorkshire and Derbyshire thick coal at Shireoakes, near Worksop, at a depth of 510 yards, without much inconvenience, from the Lower Red Sandstone, (the Upper Rothliegende of the Germans), it being very thin, fortunately, at both places; but if the Collyhurst sand had been met with at Patricroft, or the Pebley Dam sand at Shireoakes, much greater difficulties would have had to be encountered.

The Monkwearmouth and other pits, sank through the Permian beds of Durham, prove the like occurrence of the coals being merely covered up and not cut off by the overlying strata, and here also the lower sand is very variable in its occurrence, and very troublesome to get through when it is found of any great thickness.

In the three great winnings at Patricroft, Shireoakes, and Monk-

wearmouth, all overlaid by Permian deposits, no higher Coal-Measures were found than those seen outcropping in the adjoining coal-fields. In Durham and Notts it has been supposed that the pits were in each case sunk on a synclinal axis of Coal-Measures, and although the coals, before they disappeared under the Permian beds, dipped to the east, they became nearly level, and then took a westerly dip. In the Nottinghamshire and Derbyshire, as well as in the central and midland coal-fields of England, the same has been fully proved, so far as relates to Upper Coal-Measures, but not as to the occurrence of synclinal axes.

In the midland and southern coal-fields, the Permian and Triassic rocks become much attenuated, and in some cases thin out partly or altogether, with the exception of the Keuper marls. This is the case with the Golden Valley coal-field, near Bristol, where workable seams of coal have been met with at a moderate depth by sinking through the Keuper marls.

In the neighbourhood of Closeburn, in Dumfrieshire, the Mountain Limestone is covered with upper Permian sandstone. In North Lancashire, from Dalton-in-Furness to Preston, the Mountain Limestone and Millstone Grit are in contact with Permian or Triassic rocks, without any trace of profitable Coal-Measures being seen.

After leaving the Durham coal-field a little north of Darlington, Triassic or Permian beds cover the Millstone Grits all the way to the vicinity of Leeds, so that no part of the profitable coal-field is exposed. At Fountains Abbey, Knaresborough, Plumpton, and Bramham Park, Magnesian Limestone rests upon Millstone Grit.

The Derbyshire and Nottinghamshire coal-field, to the north of Sandyacre, disappears both on its strike and dip under Permian and Triassic beds. So does the small coal-field of Ashby-de-la-Zouch.

There are many more instances which could be adduced, but these are sufficient to shew the great extent of Coal-Measures covered up by Permian and Triassic deposits. The question is, how are the profitable parts to be successfully reached? That can only be safely answered by saying the Permian and Triassic strata must be carefully investigated, and their thickness ascertained as far as it is practicable to do, and then the nearest Coal-Measures must be examined so as to ascertain whether they are productive or barren of coal, and their true position and bearing with regard to the superior rocks under which they disappear, noted. This is not much information for science to give to practical men in the shape of advice in searching for unseen coal, but it is probably quite as much as can be safely given in the present state of our knowledge.

Mr. Aitkin moved a vote of thanks to Mr. Binney for his very valuable paper. He remarked that it contained a fund of information which would be of very great service to the members of the Society.

The motion was seconded, and carried by acclamation.

The Chairman said he should like to ask a question as to the character of the coal where the limestone occurred.

The President replied that the coal procured at Lebotwood was used for burning lime; it was not of good quality. On the other hand, the coal obtained at Openshaw was good, and had been used for household purposes.

The Chairman said the reason he asked the question was, that in sinking in the eastern part of Durham, below the New Red Sandstone, there was a seam of coal 2ft. 8in. thick, lying conformably with the Coal-Measures below; and on putting a

piece of this coal into the fire it came out just as it entered, not having burned at all.

The President remarked that there was nothing similar to that in these coals. He once went to look for the three worst coals in Ireland, and after some trouble, he found a coal wrought and sold as such, near Dungannon, with 85 per cent. of ash in it.

Mr. Aitkin inquired if the large extent of Coal-Measures in North Staffordshire, mentioned by Mr. Ward, lay over the higher measures seen in Manchester.

The President believed they did. He lived in hopes of seeing higher Coal-Measures in Manchester yet. He might state that in North Staffordshire, there appeared to be beds of greenstone, and some strangely mottled clays, more like volcanic ash than anything else. When he was at Canobie, the Duke of Buccleugh kindly gave him permission to employ as many men as he liked to have cuttings made, but he was unprepared at the time to make the necessary investigation.

Mr. Aitken thought that in the interest of science, such an offer should be gratefully seized.

The President remarked that when the British Association visited Manchester, and it was desired to have the marls opened at Collyhurst, Lord Derby not only granted permission, but sent half a dozen men to do the work. On the general question, it might fairly be asked whether this Spirorbis was evidence sufficient to identify the limestone at such distant places. If it stood alone, he should say there was not evidence enough; but where the other characters were also found, he thought that the Spirorbis limestone was a good guide to the position of the Upper Coal-Measures.

The Chairman thanked the President for his paper, and suggested that it might afford material for future discussion.

The President remarked that as practical men, before they could talk of the exhaustion of our supply of coal, they should know where our coal-fields began. The gentlemen connected with the Government Survey Department had not given special attention to this subject except Mr. Howell, whose treatise on the Nuneaton Coal-Field was of great value, and a model of what should be done. If the Survey Department followed this example with respect to every other coal-field, it would enable geologists to get a knowledge of the Upper Coal-Measures much better than that they now possessed.

The proceedings then terminated.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 4.] VOL. VI. [Session 1866-67.

The Monthly Meeting of the Members of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, January 29th, 1867.

E. W. BINNEY, Esq., F.R.S., F.G.S., President, in the Chair.

The President called attention to a specimen of *Goniatites Listeri*, which was intended as a donation to the Society, by some gentleman who had unfortunately not left his name. It had probably been found in the roof of the Bullion Mine, in the neighbourhood of Burnley, or from the Hard Mine, near Halifax. It was a little fractured, but it was not at all a bad specimen. Another donation was an Essay on the use of Petroleum as a fuel for steam boilers, presented by the author, who had addressed a letter to the Secretaries, which was read to the meeting.

The thanks of the Society were voted to the donors.

The President remarked that the subject of the use of Petroleum as a fuel had been brought a good deal before the public lately by Mr. Richardson and others. It appeared to him, as an old maker

of Paraffine Oil from coal, that it would be an expensive way for ordinary boilers to be heated with oil when you could get coal; because in making this oil there was a large amount of coke left, which ought to be useful for some purpose or other. In the distilling of Boghead coal there was a considerable amount of coke left, containing carbon, after the oil was extracted. In the case of marine boilers, where space was a very great object, it was a question whether Petroleum might not be used economically. In long voyages to take large stocks of coal would occupy considerable space; but if Petroleum was to be used as a fuel, he should think that coal tar, napthaline, and many other hydro-carbon compounds, would be as cheap as coal oil, or probably a combination of these substances, with crude oil, might do better than any one of them alone.

Mr. C. Livesey suggested that creosote would make a good fuel.

The President added that when there was a market for any article it was surprising how it appeared to spring up in all directions. Petroleum was now to be found in Italy, Moldavia, the East, North and South America, and in fact in almost every country throughout the world. He then called attention to some interesting specimens of insects, (on the table) found on the Lower Coal-Measures, by Mr. John Tindall, of Huddersfield. Some time since Doctor Dawson had discovered a few specimens of *Xylobius* in the North American coal-field, and they were some of the first remains of insects which had been found in the Coal-Measures. He noticed that some gentlemen in Scotland had found specimens which they set forth as being the first discovered in Great Britain; but Mr. Tindall happened to have his discovery published a couple of weeks before them. He had no doubt insects might be found in this coal-field if they were carefully looked after. When we considered the amount of foliage that was on the surface of the earth, and in the waters at the time of the coal epoch, no doubt there would be plenty of insects. He had himself a portion of an

orthopterous insect from the Upper Coal-Measures at Ardwick. In Germany, of late years, they had found fossil spiders. A good spider had been found in the Saxon coal-field, which could hardly be distinguished from a recent genus of spiders. It was worth noticing that the fossil ferns found in connection with that *Xylobius*, were the same as those in connection with the orthopterous insect at Ardwick.

Mr. Aitken then read the following paper :—

EXCURSION OF THE

MANCHESTER GEOLOGICAL SOCIETY

FROM STUBBINS TO BACUP;

By John Aitken, Esq.

Thomas Brooks, Esq., J.P., of Sunnyside, having with his accustomed liberality, and desire to promote the interests of science, kindly invited the members of this Society to visit the romantic and interesting district lying between Stubbins and Bacup, and to inspect on their way across the country, the extensive and important flag quarries belonging to the enterprising firm of Messrs. Butterworth and Brooks, situated at Foe Edge, Cragg, and Hirdles Heights, and having also expressed a wish that the excursionists would consider themselves his guests for the day, it was decided at a meeting held on the 25th of October last, to accept Mr. Brooks' kind and liberal invitation, and that the excursion should take place on the 18th of November.

Thirty-two members and friends of the Society responded to the invitation, and at the appointed time assembled at Stubbins Station, on the Lancashire and Yorkshire Railway.

The following gentlemen were present :—Thomas Brooks, Esq., J.P., the host of the day; E. W. Binney, Esq., F.R.S., President

of this Society; Professor Jevons; Lieutenant Colonel Munn; and Messrs. J. E. Forbes, F.G.S., and C. Livesey, Honorary Secretaries; John Aitken; T. Aitken; E. Ashworth; W. Beswick, C.E.; J. Chattwood; J. Diggle; R. Edmondson; R. A. Eskrigge, F.G.S.; G. C. Greenwell, F.G.S.; R. Hall; R. H. Hardman; J. Hodgson; J. Heyworth; E. Hull, F.G.S.; J. Kerr; J. Knowles; R. M. Knowles; T. Mitchell; T. Marquis; T. Newbigging; J. Plant, F.G.S.; J. Pickup; J. Parker; W. Seddon; J. Spencer; H. Stephenson; J. Whitaker, &c.

On leaving the station, the first object of interest examined was the stem of a large fossil tree which had been obtained from a quarry in the neighbourhood, and put up in a rockery with much taste, by Mr. James Porritt, who kindly invited the excursionists to pass through his grounds on their way to the quarries worked by Messrs. Porritt and Austin, in close proximity to their works at Stubbins Vale. On being appealed to as to the character of the fossil trunk, Mr. Binney gave it as his opinion, that it was the remains of a hard wood tree, and that a large scar seen on the stem probably indicated the spot from whence a branch had originally sprung.

The rock worked by Messrs. Porritt and Austin, occupies a position near the base of the Upper Millstone grit. It is well adapted for building purposes, is good in colour and clean looking, retains its colour well, and is very durable. A good example of it is seen in the handsome residences, and mills belonging to the firm. On several blocks of stone, scattered about in the quarry, incrustations of carbonate of lime were observed, some of which had assumed massive and curious forms, examples of which were pointed out and examined.

The formation of these coatings is due to the number of boulders and pebbles of Carboniferous Limestone, with which the overlying Till of the drift is charged, and which on being decomposed by the action of water and other agencies, and carried down into the

crevices and joints of the rock below and there precipitated, give rise to the formations before referred to. From this point the party proceeded along the turnpike road to Rose Bank Print Works, and thence followed the course of Dearden Clough Brook, to near its source on the high lands between Whittle Pike and Foe Edge. A short distance above the Print Works, a bed of grit rock of considerable thickness was noticed, similar in character to the rock at Bank Lane, and Messrs. Potritt and Austin's quarries; a thick mass of shale, extending past Bridge Mills to Plunge, mostly concealed by the surface drift, which here attains a thickness of fifty or sixty feet, was passed over.

At Plunge Mill, another bed of grit was encountered, extending across the narrow valley, over which the stream leaps, thus producing a picturesque waterfall. This rock is probably the first member of the Third Grit of the Geological Survey, and may be taken as the top of the Millstone Grit series. Traces of coal occur above it, but not in sufficient quantity or regularity to be described as a seam or bed. From Plunge Mill to a point where the valley makes a sudden bend to the right and changes its direction from north-east to south-east, (being fully a mile in distance) beds of strong brown shale, interstratified with flaggy layers, mostly covered toward the lower portion with drift, were passed over. One of these beds, near the top of Plunge Wood, has a thickness of about ten feet, and has been wrought to a small extent; none of the other bands appear to exceed a foot or two in thickness. In passing along this part of the gorge, the position of the flag rock was noticed on the right-hand side of the valley, forming a bold terrace along the side of the hill; good flags and other valuable stones are obtained here at Scout quarries. A short distance above the flag quarries, the Rough Rock, with its associated Feather-Edge Mine, was seen to crop out, the latter of which is also worked. Just before reaching the angle in the ravine before referred to, a fault was seen in the bank, on the south-east side of the valley, where the strata were much disturbed and nearly vertical. This

fault is evidently a down cast to the north-east of fifty or sixty feet, as the flag rock was found a few yards further on in the bed of the stream, at a level inferior to that of its outcrop at Scout quarries to that extent, it appears to have a direction similar to the more important dislocation which crosses the ravine a little higher up, and of which it is probably a minor branch. The last-named fault runs in a direction almost parallel with the line of the valley after it bends round to the south-east, passing a little on the right or south-west side of it. It has caused a considerable disturbance of the strata, the effect of which is well shown on both sides of the gorge, in the higher part of the valley, bringing up the beds in several places at a sharp angle from the horizontal. An excellent section of the fault is presented in a small lateral valley running up in the direction of Whittle Pike, where some of the strata were found in a vertical position, and the exact line of fault was well marked and clearly distinguishable. The effect of this fault is, to cause the beds of grit, previously seen in the lower part of the valley, and also the flag rock passed over just before the fault was crossed, to re-appear, and be repeated; the former in the bed of the stream, a considerable thickness of which was passed over in ascending the valley, and the latter on Foe Edge, at an elevation superior to that of its position in the brook by 255 feet.

A bed of bastard cannel, about nine inches thick, resting upon a hard curled Gannister-like rock, full of impressions of the rootlets of *Stigmaria Ficoides*, was seen near the middle of the Millstone Grit rock; this, it was considered, might be the representative of one of the Brooksbottom coals. Proceeding along the Clough, dark shales, interbanded with three or four thin seams of flaggy micaceous rock, of a dark iron gray colour, were found to succeed the grit rocks, and above these again, black finely laminated shales, in one layer of which (near the bottom) abundance of fossil ferns, and other Carboniferous fossils, are found, whilst another layer, a little higher up, is full of crushed and flattened *Goniatites*.

Having continued the examination of these shales to near the source of the stream, the party proceeded to Foe Edge Farm House, where an excellent luncheon had been provided by Mr. Brooks. After having done ample justice to the repast, the excursionists proceeded under the direction of Mr. Brooks, to visit Messrs. Butterworth and Brooks' extensive flag quarries at Foe Edge and Cragg, where he (Mr. Brooks) explained the mode of working the rock, and pointed out the various purposes for which the several layers of stone were best adapted. At both of these places beautiful smooth-faced flags are obtained on an extensive scale; some of the blocks of stone are capable of being separated into layers of the required thickness by the application of the workman's hammer and chisel, whilst others are so close bedded as to require the more powerful natural force of frost to separate them into thin laminar plates. Large quantities of the "frost rock" are brought out on to the banks of the quarries during the summer months, awaiting the return of winter, and as the rock thus split yields the most valuable flags, it may be readily imagined how anxiously the barometer is watched during the succeeding winter, by those to whom a few sharp frosty nights are of so much importance, for the first indications of the return of this powerful ally. Upon the surface of the flags a thin film or skin has been formed, intensely hard, which renders them very durable and adds greatly to their value. Flags from hence are largely supplied to the Liverpool and Manchester markets, as well as to most of the large towns in the north of England, and from the first-named town are exported to France and other parts of the Continent, and even sent out to India. Taking into consideration the durability, smoothness, and truth of the surfaces, size of the blocks, and other properties, perhaps no better flags are obtained in the United Kingdom than here.

On reaching the summit of Foe Edge, Mr. Binney gave an outline of the geological features of the district explored, commencing with the Upper Millstone Grit as seen at Stubbins; continuing his explanation of the thick shales in which three thin coals are

found at Brooksbottom; thence through the shales in which thin rocky bands occur, to the Foe Edge flag rock, and above this to the Rough Rock and Feather-Edge Mine. Mr. Binney also stated his views with regard to the formation of the valleys, which are here seen to stretch far away on the right hand and on the left. The irregular shape and contour of the country he believed was due to a number of causes, the chief agents in the work being the sea, streams, and the atmosphere. He was not willing to confine himself to any particular cause in trying to account for the scooping out of the valleys; but would be ready to accept any or all of the agents that could reasonably be suggested. But he thought that any one looking at the valleys below, and the Till lying in the bottoms and on their sides, could not have much doubt but that they had been mainly excavated before the sea deposited the Till.

Mr. Hull followed, and explained that the strata found in the district under examination, were exactly similar to those underlying the Burnley coal-basin to the north, and the great Lancashire coal-field to the south, consequently they might correctly be described as standing on a vast arch, its crown being immediately under our feet, and its two ends terminating below the afore-mentioned districts. He further believed that the whole of the surrounding locality was once an immense plain, level with the summits of its highest hills; and that in the course of ages, the valleys had been eroded or scooped out, and so made to assume their present form.

At the request of Mr. Brooks, Mr. Aitken also made some observations on the geology of the district, and pointed out the direction and extent of the Coupe fault, which was shown to pass from near the head of Coupe valley in a south-easterly direction, leaving "Top of Leach," a little to the left hand, and that it was a down-throw to the north-east of about 250 feet. The effect of this fault is to cause the Rough Rock, which occupies a position a few yards above the Cragg flag rock, (where the company were then assembled) to be repeated at a lower level across the fault on the

opposite side of the valley at Intack, thus indicating the extent of displacement. He further stated that the entire series of the Lower Coal-Measures, from the Feather-Edge Mine to the Gannister coal, inclusive, were present on the north-west side of Rowley Moor, and that the whole of which had, he believed, been removed by denudation on the up side of the fault, with the exception of the Feather-Edge Mine, a small portion of which remained near the crest of the hill above Cragg Quarries.

After leaving Cragg Quarries, the party proceeded across Rowley and Brandwood Moors, in the direction of Hell Clough Stone Quarry, passing a little to the left of "Top of Leach," the highest hill in the district, whose summit attains an elevation of 1550 feet. The top part of this hill is occupied by a small patch of the Gannister Mine, which is found cropping out round its sides near the summit. The bed is here about two feet thick, and rests upon a very fine hard crystalline Gannister floor. The extent of coal found here, which was originally only very limited, is now almost exhausted.

In passing across Brandwood Moor, the attention of the excursionists was directed to the large number of Gannister boulders strewing the beds of the several small brooklets, which issue from these elevated grounds to join the Irwell in the valley below. From their exceeding prevalance, not only in the course of the streams, but also scattered over the surface of the Moor, in several places so thickly packed as to cause the occurrence of bare bleak patches, where even the heather and other hardy upland vegetable forms have a hard struggle to maintain a sickly and stunted existence, it is natural to infer that the Gannister Mine formerly extended over the whole area of Brandwood Moor and the adjoining hills, and that it was subsequently removed by the agency of denudation, leaving only a small capping on the top of the highest hill, and the Gannister boulders to indicate its former existence.

In descending the hill, to near Hell Clough, the Rough Rock was again seen in the brook; the Feather-Edge coal found in it is here worked by Mr. James Hardman. The higher flag rock was next inspected, in Hell Clough Quarry, where it was found to occupy a position about twenty or thirty feet below the Rough Rock. The flags got here are covered with ripple marks, and have consequently rougher and more uneven surfaces than the beautiful smooth-faced flags procured at the quarries visited in the earlier part of the day, and are therefore less valuable; the rock is also stronger, and more massive in structure, and bluer in colour, than that which usually obtains in the locality. Mr. Aitken here explained that there are in this neighbourhood, two well marked beds of flag rock, the higher one occurring twenty or thirty feet, and the lower one from 250 to 300 feet below the Rough Rock; and pointed out the quarry where the company were then assembled, as an instance of the former, and Rake Head and Stacksteads Quarries, which were visible on the slope of the valley below, as belonging to the latter. The investigations of the day were here terminated, the time being too far advanced to permit of the Rake Head Quarries being visited as originally intended.

From this point, the geologists and their friends proceeded to Bacup, which they reached about four o'clock, p.m. There a substantial dinner was provided, at the Queen Hotel; the chair being occupied by Mr. Brooks, and the vice-chair by Mr. Aitken. During the course of the evening, the usual loyal and many scientific toasts were duly given and responded to by several members of the party. A vote of thanks to Mr. Brooks for his kindness and liberality in providing the day's entertainment, brought the agreeable proceedings to a close.

Mr. Aitken laid on the table two specimens of the Gannister, from Brandwood Moor, one of which exhibited the cast of a *Stigmaria Ficoides*, together with numbers of rootlets radiating therefrom, which presented the appearance of small flattened stems,

these being of a very black colour, stood out very distinctly from the white Gannister matrix in which they were embedded, on the specimen being broken open. The other specimen showed very clearly the crystalline character of the rock.

Mr. Hardwick moved and Mr. C. Livesey seconded a vote of thanks to Mr. Aitken for his interesting paper, which was carried.

The President said they were very much obliged to Mr. Aitken, not only for the account he had just given them, but also for the good arrangements he made in connection with the excursion, and which conduced so much to its success. In reference to the subject of the paper, it struck him that the bed of impure cannel which they saw going up the brook, was a bed that he had not seen before. Had Mr. Aitken seen it in any other place?

Mr. Aitken replied that he had not, but he believed that at Brooksbottom, it occupied a similar place. The coal there, however, was a pure coal, and considerably thicker than this, which was decidedly different to anything he had seen in the district before. It had a very good Gannister floor. He knocked a piece off, and the impressions of *Stigmariæ* were very distinct—at least the rootlets; and there was a very thick curled massive sort of rock, seeming almost as if it had been puddled together and congealed in that state.

The President, who briefly described the formation of Brooksbottom, said it struck him that that stone was Mr. Hall's Pease Pudding Rock, and if so, that the coal would lie a little above it, and would be the same as the lowest coal at Holcome. He held the Pease Pudding Rock to be represented by the hard road stone by the side of the old turnpike to Haslingden, above Ramsbottom. The specimens of *Stigmaria* rootlets, which Mr. Aitken had shown, were good ones. He had seen them several feet long;

they were composed of a bundle of vascular fibres in the centre, surrounded by some coarse cellular tissues. He thought that the valley at Stubbins had been formed at a very early period. There were valleys running up the sides of the Pennine Chain, with little Till in them, and that ancient deposit, resting at the bottom of the valley or on its sides. Some old geologists wished to account for everything by the action of the sea, while others thought that long before these valleys were under the waters of the sea, the atmosphere had acted upon them for countless ages, forming valleys which the sea afterwards smoothed and shaped a little. He thought that by an inspection of this deep valley, a good many facts might be gathered which would bear out the views of those who attributed these valleys to other causes than marine action.

Mr. Aitken said he thought there could be no doubt that the general conformation of the country about Ramsbottom was similar to its present shape previous to its last submersion. They found the Till running round from a height of about 700 feet in that neighbourhood to 1100 feet in the neighbourhood of Bacup; but the Till seems never to have been deposited on the higher parts. Consequently the sea could not have had anything to do with the last submersion in giving contour to the present formation of the country. He had found no shells in the neighbourhood of Bacup.

The President said there were plenty at Bowdon, but not in the Till—in the gravel above. From St. Helens to Runcorn Gap they were found in the Till, and they were abundant at Blackpool and Ormskirk, but he had seen none in Manchester. He had seen remains of shells in the sand above the Till near Kersall Moor, in very minute portions. Then in the neighbourhood of Tintwistle there was a gravelly Till very full of shells. He had looked at all the brick-yards about Manchester, but he had never seen a shell yet; nevertheless, it was possible they might yet be found by good looking.

There was no other business and the proceedings were brought to a close.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 5.] VOL. VI. [Session 1866-67.

The Monthly Meeting of the Members of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, February 26th, 1867.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

Mr. James Gee, Portsmouth, near Accrington; and Mr. George Wilde, of Bradley Colliery, Ashton-under-Lyne, were elected Members of the Society.

The President said in commencing the business, he would hand in copies of a series of printed questions, which the Commissioners appointed by Her Majesty to inquire into the extent and probable duration of our coal-fields, had sent out. Any gentleman who felt disposed could reply to such questions as he thought within his province. If all the questions were fully answered, a good deal of additional useful information would be obtained.

The President also called attention to a piece of slate that had been found in the Chevalier Slate Quarry, about a mile and a half north of Champèry, Val D'Ollierz, Switzerland, bearing two clear impressions of fern leaves, one of which appeared like a *Neuropteris*.

Mr. E. Hull, F.G.S., presented to the Society a copy of the Memoirs of the Geological Survey, "On the geology of the country around Oldham and Manchester;" and a vote of thanks was passed for the donation.

Mr. J. Ward, of Longton, was present, and exhibited some fine specimens of fossil fish, from the North Staffordshire coal-field.

The President said he used to be an industrious collector of fossil fish, some twenty-five or thirty years ago; but Mr. Ward had totally eclipsed him. Any one who had collected fossil fish in Lancashire would know that very few perfect fish were to be found. Mr. Ward, however, in his district, had got them by scores.

Mr. Plant exhibited a number of bones of the extinct bird called the Dodo, (*Didus ineptus.*)

He stated that he had received them from a friend who had been in Mauritius, last year, and had assisted in the scientific exploration for Dodo remains, under the direction of Mr. George Clark.

The collection is the first received in Manchester; and consists chiefly of bones of the legs, caudal vertebræ, and wing bones, and belonged to more than fourteen individual birds, nearly all the same size. The majority of the bones were pairs of tibiæ, and metatarsal bones; some of them very black and discoloured by the peaty mud they were found embedded in.

The discovery of remains of the Dodo in its native *habitat* was first made known in 1860, by Dr. Ayres, of Port Louis; but it was not till attention had been drawn to it by Professor Owen, that the scientific residents in Mauritius were induced to make a systematic search in 1866, when large numbers of bones were excavated from the marshy grounds and recent peat beds. The bones were wet, soft, and tender, requiring care in handling; but several nearly com-

plete skeletons have been put together, and by these the affinity of the Dodo—as first suggested by Mr. Strickland and Mr. Bartlett—to the pigeons, has been fully established. As a geological feature the bones are interesting, showing an instance of the gradual extinction of species from the earth, at a recent date, and the manner in which evidences of its extinction are procured.

Mr. Plant remarked, that he should have great pleasure in presenting a set of bones to the Society, as soon as he could make them complete.

The President said they should be glad to receive the specimens; but at present they were in a very unsettled state. The Natural History Society had closed the doors of their Museum to the public; but the Geological Society's Museum was still open to the public free of charge, and in all probability would be for a year or two longer; because he did not think there was any chance of that Museum being moved in a shorter period.

Mr. Hull assured them that the remarks he was about to make were extremely distasteful to his own feelings, and such as he hoped never to be obliged to make—certainly in that place. He then went on to say that the last part of the *Transactions* of the Society reached him on Saturday last. It contained a paper by the President, on the Upper Coal-Measures of Great Britain, which he read with considerable interest. There were many valuable points of information on the subject, though there were several with which he altogether disagreed, and which, if he had been present at the time, he should probably have expressed an opinion upon. But this he should never have thought of referring to now, had it stood alone. He wished, however, to call attention to the last paragraph in the report, which, he must say, gave him much surprise, when he read it. Had it been a mere *lapsus linguæ*, it might have been excusable; but he should have scarcely expected to see such a passage sent forth in print. The passage was as follows:—

"The President remarked that, as practical men, before they could talk of the exhaustion of our supply of coal, they should know where our coal-fields began. The gentlemen connected with the Government Survey Department had not given special attention to this subject, except Mr. Howell, whose treatise on the Nuneaton coal-field was of great value, and a model of what should be done. If the Survey Department followed this example with respect to every other coal-field, it would enable geologists to get a knowledge of the Upper Coal-Measures much better than that they now possessed." Here, as he took it, was a distinct charge brought against the Geological Survey Department of Great Britain that they had neglected a special branch of their duties—that is to say, the special investigation of the Upper Coal-Measures of the different coal-fields—with the sole and honourable exception of his colleague, Mr. Howell. Before he proceeded any further, he would ask the President to state what special coal-field he referred to.

The President:—I refer to the coal-fields of England, Ireland, and Scotland; the whole of the Coal-Measures wherever you find them.

Mr. Hull said he was satisfied with this statement. He was not personally responsible for the entire Geological Survey Department; but, if he had time, he should have been able to shew that such a charge was altogether unfounded. He would take those coal-fields in which he had been specially engaged, and he thought he could not do better than refer to the Upper Coal-Measures of Lancashire, including, of course, the coal-field of Manchester. Their duties, as connected with the Department, consisted of these several particulars: They were required to make a complete geological map of each district, both on the six and one inch scales; to run level horizontal sections over these districts; to gain all the information they could, either acquired by hearsay, by reports, by books, or by their own investigations; and to write short descriptive memoirs of these districts. They were not obliged to do more than that, and he did not think they could be reason-

ably expected to do more. With regard to the Upper Coal-Measures of Lancashire, he ventured to say, that if any gentleman would take the trouble to look over the documents of the Survey Department, they would find that every information that it was possible for them to furnish had been supplied to the public. Mr. Hull then produced several of the Survey maps, remarking that he had had the honour to present one to the Society. Here they had the boundaries of the Manchester coal-field as accurately traced as it was possible. He had availed himself of the very valuable information which their President (Mr. Binney) had collected, and had given him credit for it.

The President:—I deny that they have done it in all cases.

Mr. Hull, in continuation, pointed out all that the maps contained, remarking that they were accompanied by descriptions; and said that there were also in the Memoirs* which he had presented to the Society, no less than five pages devoted specially to a description of these Upper Coal-Measures, besides several references when treating of the new red sandstone. He did not know that he had omitted from these any information which had come into his possession, and which he had been able to acquire. Therefore, he thought he had done what was his duty with regard to the Upper Coal-Measures of that district. If they went on to the other parts of the coal-field, they would similarly find maps, horizontal sections, descriptions, and memoirs. He produced maps of the several districts he mentioned, and said that where Memoirs had not also been given, this arose from the fact, that the district in question had been surveyed before permission had been given to the Department to publish these Memoirs. In conclusion, Mr. Hull repeated that he should have considered he had not done his duty had he allowed the President's assertion to pass unanswered.

* "Geology of the Country around Oldham, &c.," pp. 33—37, and 40; also plate 1 (Fossils.)

The President, in replying, read the passage complained of. "As practical men, before they could talk of the exhaustion of our supply of coal, they should know where our coal-fields began." He saw nothing to alter these. He held that if you began to talk of the exhaustion of our coal, you should get to know where the coal-field begins. He would begin at the beginning in that respect. "The gentlemen connected with the Government Survey Department had not given special attention to this subject, except Mr. Howell, whose treatise on the Nuneaton coal-field was of great value, and a model of what should be done." He would endorse every word said there. He made no charge against the Geological Survey Department. He merely said they had not paid special attention to this branch of the subject, and that he would reiterate. He had spent some thirty years upon the Upper Coal-Measures, and therefore he wrote the above after due deliberation, and after having given—not in any official position, certainly—but so many years to the elucidation of the subject. He did not pretend to say that he, who had business and other engagements, could devote himself so completely to the work as an official who was paid by the nation to give his whole time to it. He was a mere amateur geologist, and as such he gave his knowledge to the public for what it was worth. He had said nothing in disparagement of Mr. Hull, or any other gentleman. He held that the words special attention reflected no censure upon Mr. Hull. He could not agree in Mr. Hull's assertion that the four or five pages in the Memoir, or the descriptions referred to, contained anything like a complete statement of the present state of knowledge on the subject, in Lancashire, so as to prove that special attention had been directed to it. Where he had found special attention he had named it. He repeated that Mr. Howell had published a Memoir, in which he gave these particular coal-measures in considerable detail. By giving praise to Mr. Howell, he did not put any blame on the other gentlemen. In proof that special attention had not been given to the subject, he would mention that in this district there were nearly 300 feet of Upper Coal-Measures,

discovered within the last twenty years, more than were mentioned in Mr. Hull's Memoir, but given in my paper. He was coming to a point he never should have named voluntarily, and he had, before the meeting, requested Mr. Hull, on that account, not to introduce the subject. When Mr. Hull was in the Prescot district he surveyed it, and omitted the Upper Coal-Measures altogether out of it. He (Mr. Binney) communicated with Professor Ramsay, and said the map ought not to go out with such an omission in it. The Professor asked him to go down with Mr. Hull; he took him to Whiston and St. Helens, and showed him those particular measures which he had passed over and never seen, and put him right in the subject. He did this at his own expense of money and time, and yet, when Mr. Hull's Memoir appeared, he never named a word about it.

Mr. Hull ventured to say that notice was taken of Mr. Binney's efforts.

The President, in continuation, said he knew the map was altered at his suggestion, and it appears, with the alteration, in the Memoirs on Prescot, without any mention of that fact. The Memoir spoke for itself. He thought if they were to have a fair state of the knowledge of the time given in these Memoirs, credit should be given to those gentlemen who had done some of the work. He repeated that what Mr. Hull took for blame was not meant for blame; but as Mr. Hull had come forward and charged him with doing an injustice to the Survey Department, he (the President) had a right to defend himself, and shew what Mr. Hull had done with the Upper Coal-Measures in Lancashire.

Mr. Hull said he had now to remark that he was very much indebted to Mr. Binney in the matter of the section near Prescot, and he thought Mr. Binney would be satisfied with the way in which he was acknowledged in the second edition of the Memoirs; but the statement that he had omitted the Upper Coal-Measures of

that neighbourhood was not correct. The omission was a bed of limestone of four feet in thickness in the railway cutting at Whiston, and which happened to have been covered up from view when he visited the spot. This, Mr. Binney would confirm, as he (Mr. Binney) was obliged to remove the covering before he could shew the limestone to him—at the time of his visit. He (Mr. Hull) regretted that he had omitted to give Mr. Binney special thanks, in the Memoirs, for this service—which any one who would glance over the Memoirs of South Lancashire would allow was a crime of which he had been rarely guilty. At the same time, it would be observed that the charge of Mr. Binney *now* was not one of neglect of giving special attention to the Upper Coal-Measures, but of giving credit to authors, and he (Mr. Hull) was quite willing to leave this matter to the judgment of the Society. He had shewn no indisposition to give credit to Mr. Binney for his valuable researches. On the contrary, in the Memoir he had just presented to the Society, Mr. Binney's name appeared on almost every page.

In response to an invitation from the President—

Mr. Dickinson said he had nothing to do with the matter; but, he took it, that these maps contained the information which had been supplied to the Geological Surveyors, chiefly by those who had knowledge of the district. As regarded the coal-fields, many of them were so thoroughly covered up that they could not now be seen, and the only information respecting them must be obtained from the colliery owners and engineers, and if their names were omitted, he thought it might be well if Mr. Hull hereafter would give them. It was the least return which could be made to the persons who furnished information.

Mr. Hull replied that he did give such a list. If he did not always do so, it was because the names were so numerous that it would be nearly impossible to mention all.

The meeting terminated with a vote of thanks to the Chairman.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 6.] VOL. VI. [Session 1866-67.]

The Monthly Meeting of Members of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, March 26th, 1867.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

Mr. H. H. Bolton, of the Baxendale Colliery, Accrington; and Mr. William Evans, Apsley Villa, Cheetham Hill, were elected members of the Society.

Mr. Dickinson remarked that there was a most important question to them in the papers of Saturday last, in relation to certain experiments which had been made at the Hetton Colliery with the Davy lamp. It was some years since himself, with Mr. Horsfall and the late Mr. Goodwin wanted that Society to institute a set of experiments as to the velocity with which it was necessary for fire-damp to impinge against a Davy lamp to cause an explosion. They were prevented from making experiments at the time from causes.

which he need not then state, but the matter had since been taken up by the North of England Institute of Mining Engineers. Their first series of experiments had already been published. They were made in a box in which was a lamp revolving at certain velocities ascertained with great care, but it was found that they were not sufficiently accurate, as there might be a momentary increase at the time of the explosion, and the mere motion of the lamp might cause a certain eddy. Means were adopted to prevent as much as possible these effects, but still there was the after-damp caused by the lamp burning the gas; so although they found that by revolving the lamp in this box, they could fire through the lamp at a velocity of 13 feet per second, they determined to resort to more accurate experiments. They had since made these experiments, and he thought they had now got them on such a footing that they were an exact model of what took place in a coal mine when an explosion occurred. They got a wooden pipe 12½ inches by 5½ inches in section, with glass windows at one side, and hinged top, in which the safety lamp was placed, opposite one window, and one of his (Dickinson's) anemometers opposite another, which showed by the inclination of the vane, the exact velocity during the whole of the experiment. By mixing the gases in certain fixed proportions, and travelling at a certain velocity, about 8 feet per second, the lamp begins to heat, and in three or four seconds it explodes outside. It was certainly an alarming state of things. The Davy lamp was clearly proved to be unsafe in a velocity of between 400 and 500 feet per minute, and that was a daily velocity in mines. Should an outburst of gas take place, as occasionally occurred, and any Davy lamp be exposed to it for three of four seconds, it was unsafe. These experiments had been made with fire-damp, and with common house gas, and it was found, as generally understood, that the house gas was rather more explosive than the fire-damp. In taking the proportions at which the fire-damp was most explosive, it was ascertained to be one of fire-damp, and seven of air; but probably that arose from their being a little carbonic-acid with the fire-damp.

The President remarked that there might be other matters mixed with it as well. The proportions of air and fire-damp were generally given from 7 to 9 as the most explosive mixture.

Mr. Dickinson said that through the kindness of Mr. Lindsay Wood, and Mr. John Daglish, he had seen the experiments made a fortnight ago in the Hetton Colliery, and the thanks of the mining community were due to the Northern Engineers for carrying out these experiments.

The President said they had always held—in the *Manchester Geological Society*—the opinion that the Davy lamp would explode on being subject to a strong current of air in an explosive atmosphere. Some years ago they formed a committee to consider the subject, and some experiments were made.

Mr. Dickinson added that the Eloin, which is one of the Belgian lamps, not much used, and the Stephenson lamp went out, while the Clanney and the Davy both exploded. The Mueseler lamp has not been tested.

The President remarked that Sir Humphrey Davy himself, in his first paper suggested that a screen should be used with his lamp to protect it.

Mr. Dickinson said the only shield that became of any use was one which went almost entirely round the gauze, so as to prevent the current of air impinging against the gauze.

The President said that all lamps entrusted to common miners should be made so as to go out when they came in contact with fire-damp. They also should all be self-extinguishing lamps on being opened or attempted to be opened.

The following paper was then read :—

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ON THE EXISTING METHODS FOR EXTINGUISHING FIRES IN COAL-MINES, AND A NEW METHOD SUGGESTED FOR THE CONSIDERATION OF THE MEETING:

By Mr. James Atherton.

Having been invited by Mr. Binney, President of your Society, to furnish material for this day's discussion, I have chosen or supplied the subject which has just been read in your hearing. It is not so much my intention to read a set paper upon this question, as to lay hold of a great salient point, and, coupled with my own, endeavour to elicit the opinion of this meeting upon it. What is meant by a review of existing methods of extinguishing fire in mines, is simply a concise and laconic statement of what means were hitherto employed, and what results followed, where fires have been known to take place.

Mining, I need not tell you, has taken its place among the sciences, the most valuable theories have been constructed, arising out of profound experience and enlarged practice; theories in harmony with certain well-known laws of nature, opposition to which cannot be signalized with impunity, and without terrible results; it is sufficient to know in one district what is done in another, to extinguish fire, and we can predict the issue with precision. But profound and extensive as are the experiences of engineers in wielding and controlling such a vast centralized class of mining industry, accidents cannot be avoided. Because of this, the public reflect upon the imperfections of the science, and the want of ability in colliery managers. In this they are guilty of partial injustice to say the least, inasmuch as other large branches of industry are not exempt from these, though their occupation is not beset with danger to life and limb at every step, as is known to be the case with the operative miner. The public mind has been

shocked at the recent calamities that have taken place, but has recovered from its first paroxysms of grief. Engineers on their part have stood appalled, and still retain their first impressions, and are more than ever alive to their responsibilities. To prevent all accidents, however, they are powerless, as is to be seen in the sequence of the Oaks catastrophe, where men of science and the poorest miner meet with a common fate. Amid these disasters, it is pleasing to chronicle that much has been accomplished to save life and property, and even Engineers are prepared to admit, that loss of life upon so large a scale may be prevented.

My paper and this discussion points to the saving of property and time from the ravages of fires in mines. The occurrence of fires in mines, and to the modes of extinguishing same, to which reference is made, may be traced to a variety of causes. They originate sometimes in spontaneous combustion; from blasting coal, when large quantities of carburetted hydrogen gas is given off; frequently at the stables; sometimes the wilful act of an incendiary; also from imperfectly constructed furnaces; but frequently and attended with most disastrous results, those which are originated by a great explosion, such as the Edmonds Main, and the Oaks Collieries at Barnsley. Some of these fires are and have been of small sectional area, others have spread to extraordinary dimensions and magnitude. This, I need not state, is a class of casualties incident to mining operations, and which frequently taxes the extraordinary energies and skill of its Engineers; the efforts of whom in this direction have been attended with various success.

Till of late, since science has given more consistency and uniformity in the means at present adopted to extinguish fire, the methods that were used were as numerous as the causes of the fires, previously indicated. When a fire has unfortunately taken place in a colliery, one Engineer will make up and wall off the place where the fire is raging, relying upon the action of carbonic-acid gas, the product of combustion, to extinguish the fire. Another Engineer

would do all that, and, in addition, begins operations with places to cut round the locality of the fire, with the conviction that if he thus circumvent it, and pass through that course a brisk current of air, he will successfully dispose of all radiated heat, and prevent the spread of the fire. A third Engineer I have known adopt neither of these means, but having a large pump in his shaft, he connects, 60 yards up the pit, a three inch pipe to the pump, conveys water 700 yards to the seat of the fire, where, with three relays of men in the twenty-four hours, and at an immense cost, for four years, played upon the fire, while the fire in return constantly evaporated both his water and his coal. Another Engineer has been known to construct an apparatus on the pit bank, and by aid of mechanical power pass an injection of carbonic-acid gas into the mine, with a view to extinguish the fire, and with what results some of you know. A more thorough acquaintance, however, with the chemistry of these gases, has taught modern Engineers that it is better to convert the mine into one vast laboratory for the production of this agent; give nature breathing time, and let the fire work out its own extinction. The last alternative, which to my own mind, as well as others present, I am sure, is the most to be avoided, if there be anything within the whole range of science that can otherwise accomplish the object, I mean the filling of the mine with water.

From the instances I have quoted of the different methods adopted by different Engineers to extinguish fire in their respective mines, it is quite clear that there is a conviction that carbonic-acid gas is the great agent to be relied upon in these emergencies. I am quite of opinion myself that this is a powerful and an effectual agent in extinguishing fire, if you will only give it time; and in mines that are free from fire-damp, you may resort to it at any time, with unbounded confidence in the result; but in mines that give off much gas, and the flame is exposed before you can operate, the two brought into contact, are followed by explosion after explosion, spreading death and devastation on every hand. What is to be done then? Of course the same agent is called into requisition;

the pits are all sealed, except a pipe to test pressure and temperature of the gas at the pit's mouth. Of the two alternatives, both of which are fearful enough, viz. :—the sealing of the shafts, or filling them with water, the former is to be desired, although the uncertainty as to the time of opening is to be deplored. To say how long the Oaks Colliery shall be sealed, and when opened, is impossible for the ablest Engineer, and all the Engineers that were there in consultation, to say.

Is it not, however, humiliating, Mr. President, to have to confess that we have done all we can, and yet doing so little? This is as far as engineering ability in these matters ever went, and can at present go no further. These very difficulties in the way of being able to fix a time when those dead bodies can be brought up for interment, form the great barrier before which the engineering skill of this country is called upon to halt. They have spoken out most unmistakably,—hitherto shalt thou go, but no farther. The enemy has slaughtered your men by hundreds, and still retains his prey, and dares you to wrest it from his hands.

This, Mr. President, is the particular point upon which I should like to know if anything can be done or suggested; that when, in cases of great general fires, involving the sealing of pits for months, may be years, by which such mines can be restored in a comparatively short time. Take the Oaks Colliery, for instance. Here is an amount from £70,000 to £100,000 of utilized capital thrown into disuse; is paralized; lies in scattered fragments and ruins; to say nothing of the painful associations inseparable from even the distant recovery of those mines. Why should this be the case? A great deal has been done for mining since Stephenson constructed his Geordy, Davy his Safety Lamp, and Buddle began to split his currents of air. Chemistry has unfolded its wonders, as much to the interest of Mining Engineers and in the interest of mining operators, as to any other class in the world. Pneumatics have shed a ray of light upon these matters within the last quarter

of a century, which was never so thoroughly understood and appreciated before, while applied Mechanics leaves you scarcely anything to desire. The Barometer and Thermometer, with their indisputable indications, bearing upon the interest of mining operations, once but so little understood, are so familiarized to yourselves as to become philosophical playthings. And much as these branches of science have conferred upon the safety of mining operations, they will yield still more to the hand of steady and patient investigation.

Referring to the latter portion of the notice of this meeting, which states that I shall offer suggestions upon a *New Method of Extinguishing Fire in Mines*, that is intended to apply to mines more particularly upon which fire has taken extensive hold, and in mines giving off large quantities of fire-damp, which renders it unsafe to be dealt with in the workings, and when the only alternatives left are those of either sealing the shafts, or inundating.

In stating this, I may observe, I have no personal end or interest to answer; but simply enunciate and explain that method to be received or rejected upon its own merits. I may remark also, however, that while the *theory* is not dogmatically given as infallible, yet, from the eminent opinion I shall quote in the course of this debate, as to the practicability of its application and success, it may nevertheless be entitled to some respect.

My own opinion is, that however largely a fire has taken hold of a mine, there is no necessity of inundation to extinguish it; and also, that the indefinite length of time at present required, by sealing the shafts, in order to extinguish it by the action of carbonic-acid gas, may be shortened to a minimum of eight or ten days.

The method I propose to adopt would be the application of a powerful exhausting air cylinder, with a view—so far as is in the

power of mechanism—to *produce* or *create* a *vacuum* in the mines. To point out to you the amazing capabilities of such a machine, I have chosen as a basis of calculation a mine, the open workings of which equal an area of 300 statute acres, and that this mine shall be eight feet thick of a seam of coal. I take this large area to show that it will apply to a large colliery as well as to one of small dimensions. Now such an area will give 104,544,000 cubic feet. The exhausting cylinder I propose to operate upon this mass is of the following dimensions, viz.: Cylinder, six feet diameter; eight feet stroke; thirty strokes per minute; which, being double, equals one stroke per second, or sixty per minute.

Such a machine, in operation as just now indicated, and assuming no accident or derangement to its mechanism, and that it were possible to create a perfect vacuum, a thing for which I do not contend, it would exhaust, in five days and a half, the whole of the 104,544,000 cubic feet, or the contents of 300 acres. If it be thought that thirty double strokes be too many, work it fifteen, and then you accomplish the same results in eleven days. Suppose, again, that you inundate the same area, and fill every cavity of the mine with water. You have got to pump out, or otherwise wind, the enormous quantity of 2,916,964 tons; which, calculating whether to be got out again by winding or the pump, would require, at the rate of two tons per minute, the space of two years ten months and two days to clear the mines; to say nothing of the deteriorated condition of the workings. And this, bear in mind, is assuming that the workings all lay to the crop of the shafts, and no difficulty in the way by having to bring it from down-brow workings. (See plan explained.)

But is it possible, it may be asked, to create a vacuum in mines? Personally, I believe it is to a certain extent; but in order that this opinion may receive additional weight, I quote the opinion of a gentleman who is an eminent Engineer, and whom I personally consulted after my first thinkings upon this subject. It is as fol-

lows:—"An exhausting cylinder may be constructed and successfully applied to secure, to a certain extent, a vacuum in mines; that extent would be limited to about 12½ pounds upon the square inch."

It may be asked, suppose a vacuum procured; would it extinguish fire? There cannot, I apprehend, be a doubt upon that question. And those who like myself have seen fires rage in mines, must have been struck with the rapidity with which they travel; and, considering the affinity of flame to all bituminous substances, and an atmospheric pressure of 14·7 pounds upon the square inch, heightened again by the depth of the mines, must think that so soon as this pressure is taken off by the cylinder, that every calory of heat must surrender itself into that *void*, and pass away.

With regard to the influence of a vacuum upon heated substances, I quote you the opinion of Doctor Black, the discover of latent heat, viz:—"Every hot body in the act of cooling, besides losing heat by the conduction and convective action of the solids and fluids in its neighbourhood, parts with much heat by radiation. Rays of heat pass away from the hot body, till it has reached the temperature of the air or surrounding medium. In proof of this, it is only necessary to hang a hot body in the *vacuum* of the *air-pump* when it *rapidly cools*, although it does not lose its heat either by convection or conduction."

Create this vacuum and you let loose another cooling agent, were it required, viz: carburetted-hydrogen gas or fire-damp. In a shaft 300 yards deep you get an atmospheric pressure equal to fifteen pounds upon the square inch. Gas exuding from the mines, in the face of this pressure, must of necessity be subject to a higher latent force from within; and possessing, as it does, such high cooling properties, would act as an additional extinguisher under these conditions.

In reference to sealing the shafts, that would have to be done effectually, owing to the fact, that in the area of a twelve feet shaft you have an atmospheric pressure equal to 106 tons. The particulars are indicated upon the plan.

Air-Valves.—To protect, while clacks are repaired; steam power they have; the cylinder might afterwards be converted into a pumping engine. The original cost of the whole apparatus about £1800.

Mr. A. Knowles begged to propose that the thanks of the Society be given to Mr. Atherton for the very valuable communication he had made to them.

Mr. Aitken seconded the motion, which was carried.

A rather lengthy discussion ensued.

Mr. Greenwell asked if Mr. Atherton, in his calculations, had made provision for the liberation of gas at the same time as the drawing out of the air?

Mr. Atherton said he had.

Mr. Aitken remarked that Mr. Atherton had stated that large quantities of carburetted hydrogen gas would be liberated; and he would therefore ask, if with the fire still in a mine, there would not be a danger of further explosion?

Mr. Atherton replied that there could not possibly be an explosion from this cause, inasmuch as all ingress of atmospheric current to the mine was prevented by sealing the shafts, and which air was essential to an explosion.

Mr. Greenwell thought this was scarcely an answer to the question. Supposing there was a large fire going on in a mine, and that the mine liberated fire-damp in certain quantities. At the time the fire is going on there is not a sufficient quantity of gas to produce an explosion; but as soon as you apply your exhausting principle, you immediately increase the exudation of fire-damp from that mine, the mine being still, to a certain extent, filled with atmospheric air; and thus you would get a mixture which, from being inexplosive before, now becomes explosive. Would not an explosion then take place?

Mr. Atherton did not see that, because while you were operating with the machine upon the agglomerated mass, you had there a number of undefined gases mixed up with the carburetted hydrogen gas, and which required a considerable volume of pure atmospheric air to explode them, which would not be supplied.

Mr. Dickinson said that all who had had much to do with the extinction of fires in coal mines knew that at the first when you shut off the fire, there was at the time the fire-damp was being given off and mixing with the air, a period when there might possibly be an explosion. He thought, perhaps, on an average, an explosion occurred, certainly not oftener than once in four times. There seemed to be round about a fire such a mass of choke-damp that it often prevented the explosion taking place. But sometimes it did take place. He had seen several instances of this. He had seen when the top of a pit had been covered up, a violent explosion take place, and scores of tons of rubbish shot into the air. Mr. Atherton's apparatus, he thought, should not be used to a pit until this explosive point had been passed. There were other points, in which he thought the machine might do service. He then remarked that the cylinder being 6 feet in diameter, and a pressure of 12½ lbs. per square inch being required upon a piston 6 feet in diameter, and working 30 double strokes per minute, would require a tremendous horse power. But still, if they could shorten the time of the

fire not to only eight or ten days but to one month, or even to several months, that would be a consideration. If these were facts which had been stated—and they had not as yet been challenged—if the producing a vacuum in the mine would tend to facilitate the absorption of the heat, and thereby lessen the time the mine had to be shut up, he thought it would be a great boon to colliery proprietors to have such a means placed within their reach. In a large number of instances it was not necessary to apply the pump to the shaft. In nine cases out of ten you had only to deal with an isolated portion of the mine; but if the exhaustion of the air would facilitate the operation it would be an advantage. There seemed to be nothing which had such an effect in dulling the surface of the fire as high-pressure steam. All these methods had been tried, and sometimes were successful, while at other times they were not successful. One person found a particular method to answer, and he was loud in its praises; while another, having failed with the same method, was equally loud in its condemnation. Some had put out fires with water engines; but he watched an instance last year very carefully, and the fire engine failed altogether; they were obliged to shut off. He had known fires shut off for months, and there had been still sufficient heat left that as soon as the air was applied the fire broke out again. The fact was, that what seemed to succeed in one instance did not succeed in another. You could extinguish the flame, but you had the heat left, and if this apparatus succeeded in getting the heat away, it would be a step in advance.

Mr. A. Knowles inquired if the apparatus had ever been tried?

Mr. Atherton replied that it was simply a suggestion.

The President said it appeared to him that this plan would have a considerable effect in the early stages of fire, when the flame had simply to be put out; but he did not see how it would act in the case of fires which had been burning for months or even years.

In fact, there was a mine in Scotland, which had been on fire for a hundred years, and was on fire now. When a fire got great hold of a pit, and especially with a black shale roof, it appeared to be a very difficult matter to get that fire out. He knew of an instance where a pit was full of water twelve months, and after they had pumped out the water and worked for some time, a great mass of red hot black bass came down from the roof. It was very easy to get quit of flame; but to get rid of a great mass of burning black shale, they must radiate the heat away. He did not see, exactly, how Mr. Atherton's apparatus would answer in this case.

Mr. Aitken thought this case seemed to prove that fire could be sustained without atmospheric air.

Mr. A. Knowles said Mr. Atherton proposed to close the down-cast shaft and then to place this machine on the up-cast, to cause a vacuum, and the question was—Would it draw out the heat from the fire in the mine?

Mr. Atherton replied that the heat must surrender itself to the vacuum created by the machine, and so pass away.

Mr. Knowles said if the apparatus, in practice, would really exhaust the heat, he thought it was one of the most valuable means of extinguishing fires that had been suggested.

Mr. Greenwell thought that the plan would be very effective in cases where fire-damp did not issue from the mines; but in cases where fire-damp was issuing, he had a strong impression that before it came to act upon the fire-damp the explosion would take place.

Mr. Dickinson said it would also be effective after the air in the mine had become mixed with fire-damp beyond the explosive points.

Mr. A. Knowles said he thought there was another consideration which ought to be taken into account, and that was as to the effect of producing a vacuum in a mine which possibly might draw in the roads and workings. Even now, change your system of ventilation, turn your up-cast into a down-cast, and the change in pressure from the lessening of the heat near the up-cast had a great effect in drawing in the roads. And to draw all atmospheric pressure out of a mine, you would have all the roads come together, and in some cases the whole thing might be closed up. He had known a colliery where this change in system had been made, and where the effects were very serious.

Mr. Clegg Livesey said he had good evidence of the value of fire-damp, as an assistant in putting out fire, about twelve months ago. Having been sent for to one of their collieries, he found that a man had set fire to a large body of gas which was rushing out of some old workings. This had occurred seven or eight hours previously, and a great mass of black shale was burning fiercely. The underlooker had cut a road to the place and procured a fire-engine. After playing upon the fire until the flame was extinguished, nothing more remained for us to do. The gas passing over and through the red-hot shales appeared to cool the mass far more quickly than water could have done. The effect was almost magical.

Mr. Aitken remarked that Mr. Atherton's apparatus was rather bulky and costly; and supposing its practical utility were established, it would hardly be necessary for every colliery owner to have one. the only way, perhaps, to meet this, would be by a number of colliery owners in one district subscribing and having one ready to be used in case of need; but, in that case, it would take considerable time and great expense.

Mr. Atherton briefly replied on the discussion, observing, he was glad that the value of the principle contained in his suggestion was

admitted; that the size of the cylinder and number of strokes might be moderated as circumstances dictated; that no apprehensions need be entertained as to a collapse of the underground workings, when the vacuum was created; that the machine was not patented nor ever intended to be, but had originated in a strong conviction that by use of such an instrument or the adoption of such a method, —it mattered not how large a fire in mines, or under whatever known circumstances — the destruction of property might be arrested, and the suspension of operations be reduced to a very small minimum of time.

The proceedings terminated with a vote of thanks to the President.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 7.] VOL. VI. [Session 1866-67.

The Monthly Meeting of the Members of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, April 30th, 1867.

E. W. BINNEY, Esq., F.R.S., F.G.S., President, in the Chair.

The President remarked that at the previous meeting a paper was read by Mr. Atherton on the "Extinction of Fires in Mines;" since that date he had received the following letter:—

"Manchester, 28th March, 1867.

"SIR,—In the *Manchester Guardian* we see that a meeting of the *Manchester Geological Society* has been held in Manchester, to take into consideration the existing methods of extinguishing fires in coal-mines; and also, the method of adding to the present means, a surer and more expeditious method of doing it. We beg to suggest for your consideration the method of accomplishing it by steam, inasmuch as the steam that would be required to drive the exhausting engine or cylinder, could be used for the purpose—*plenty* of boiler room, to stand a pressure of 60 to 100 lbs., with a steam pipe of about 15in. or 12in. diameter carried down to the bottom of the mine and along it as far as was thought requisite—would, we believe, extinguish the fire in a mine, by stopping up all the air entrances into the mine, so as to prevent the steam coming out.

"We are, Sir,

"Yours respectfully,

"HENRY LEES & BRO."

Mr. Greenwell thought it would be a rather difficult matter to put down a steam pipe in the shaft of a pit, under such circumstances as those of the Oaks catastrophe at Barnsley.

Mr. Dickinson said if the writers had read the discussion as well as the paper, they would have found that he pointed out high-pressure steam as being a useful mode of putting out fires, in addition to those named by Mr. Atherton. He had seen it tried, and when applied it had a remarkable effect in dulling the fire, to such an extent that it might be dealt with by the spade. He had known some fires, after being shut up and Gurney's system tried—as at the Black Brook Colliery, at St. Helens—put out with steam in that way.

Mr. A. Knowles said he had known cases where steam had been found very effective in connection with fires that had been merely on the surface. With fires that had got great hold he thought it would not be of much use.

The President said the great thing to be obtained was the means of dealing effectually with an old fire of twenty, thirty, or fifty years' standing.

The subject then dropped.

The President said that since their last meeting the Members had had an excursion, and as, generally speaking, some account of the excursion was given, he had put down a few remarks, which he would read :—

NOTES ON THE EXCURSION

OF THE MEMBERS OF THE MANCHESTER GEOLOGICAL SOCIETY TO DISLEY;

By E. W. Binney, Esq., F.R.S., F.G.S.

On Saturday, the 15th April, the second excursion of the Members of the Society for the present session took place. At 9 a.m., Mr. Binney, President of the Society, Messrs. Aitken, Diggle, Hull, Johnson, A. Knowles, J. Knowles, Lees, Livesey, Parker, Peace, Spence, and Spencer, met at the London-road Station, and proceeded by rail to Disley, where they were received by Mr. Greenwell, who conducted the party up the hill to the high land above Lyme Park. The first rock seen was the Rough Rock; and Mr. Hull pointed out the place in the valley below where the Feather Edge coal had been wrought. When on the summit of the ridge, a fine view was seen of the beautiful valleys to the south and east, forming the extensive water shed of the Goyt. Although terraces were seen on some of the hill sides, which advocates of the marine excavation of these valleys might claim as evidence in support of their views, still the whole of the appearances seemed to shew the effects of long continued atmospheric and fluviatile causes, rather than the action of the sea. After passing Bow Stones, we turned to the west of the Park wall, and soon came on some old coal pits where the Sweet seam of coal had been got. In a new sinking on the common above Bakstondale we saw the Upper Smut Coal, and about 40 yards below it the Lower Smut, which would have to be passed through before the Sweet seam was reached. This spot would be at an elevation of near 1000 feet above the sea, and the strata were covered by some 12 feet of bluish till, containing large rounded boulders of granites, greenstones, and other rocks, of one or two hundred weights each. The Upper Smut Coal appeared to occupy the position of the Forty Yards Coal of Bacup, and the Lower Smut that of the Upper Foot of Oldham, and other places. Between these seams a thick mass of black shales occurred; and in the valley where the Shrigley brook flows, we saw the position of the Lower

Smut, but the coal had thinned out. In the roof, however, although we found no calcareous nodules so commonly met with in other places in Lancashire in that position, there was an abundance of *Goniatites Listeri*, *Aviculopecten* and *Posidonia*. Under the coal a Sandstone rock occurred, which appeared to occupy the position of the Tumbling Cob rock of Rochdale, and at about 14 yards below, we came to the Sweet seam, of about 18 inches in thickness, resting on a Gannister floor, varying from 8 to 18 inches thick, under which a good fire-clay of about one foot occurred. The coal appeared to be of a fair quality, and contained some nodules of ironstone in it, but we did not see the calcareous nodules so generally found in this seam near Burnley, where it and the Upper-Foot mine come together. After passing the fire-brick works shewn us by Mr. Lambert, we saw a portion of the Upper Flag rock brought in by a fault, which would appear to shew that the Sweet coal had been thrown down, and the Upper Smut, we were informed, had been seen in the brook course, but we did not find it.

We went down the road to Pot-Shrigley, where Mr. Greenwell had prepared an excellent luncheon in the School Room kindly lent by the Clergyman of the place. While discussing the fare provided for us, Mr. Davenport, agent for the Rev. Mr. Lowther, favoured us by producing the plans of the collieries on the Shrigley estate, and Messrs. Needham and Lambert kindly afforded us much valuable information as to the coal seams and rocks of the district. Under the Sweet coal occurred the Stinkard seam, and then, apparently occupying the position of the Salts mine, came the Ribbon, and further down the Lime Kiln coal, most probably the same as the Feather Edge seam, was met with. However, these beds we did not see in any section.

After our rest at Shrigley we went into the Park, and examined two other quarries of the Upper Flag rock, and on the Styperston Road saw the red ochery clay, which had been supposed to be the outcrop of a bed of red hæmatite. We then proceeded to the ex-

tensive quarry of Styperston Park, where another portion of the Upper Flag rock has been wrought. The quarry contains some thick beds of good stone, and the rock is traversed with vertical fissures of from one to two feet in width. In one portion of the quarry was a deep pool of water of a bright green colour, which attracted the attention of the party. I have seen similar instances of green coloured water in the mountain Limestone district of North Derbyshire, and the Burdiehouse Limestone Quarry at East Calder, near Edinburgh; so the colour may be probably due to a salt of lime in solution.

We did not see the Coal-measures in contact with any Permian or Triassic rocks to the west, although we were informed that they had been met with in the new railway cutting near to Bollington; nor did we ascertain the exact distance and character of the strata lying between the Redacre coal, supposed to be the same as the Lower Woodley, or Arley Mine, and the Forty Yards Coal, but we found a part of the Upper Flag rock, and a considerable portion of the lower coal-field. The sequence of the seams appeared to be similar to that given by Mr. A. H. Green, F.G.S., in the "Memoir of the Geological Survey of the Country round Stockport, Macclesfield and Leek," page 23.

		Ft.	Ins.		Ft.	Ins.
1	Kerredge Rock	—	—	to	—	—
2	Shales	—	—	to	—	—
3	Coal, *Great Smut*	2	6	to	—	—
4	Measures, Shales, &c.	100	0	to	140	0
5	Coal, *Little Smut*	0	0	to	1	1
6	Measures	36	0	to	0	0
7	Coal, *Shore or Sweet Seam*	1	6	to	2	0
8	Measures	12	0	to	24	0
9	Coal, *Stinkard*	0	3	to	1	0
10	Measures	30	0	to	54	0
11	Coal, *Ribbon*	0	0	to	0	10
12	Measures	90	0	to	120	0
13	Coal, *Big Mine*	4	0	to	6	0

Resting on the Rough Rock.

After leaving Styperston Quarry, the party walked on to the Vernon Arms, Poynton, and partook of an excellent dinner. In the addresses delivered during the evening, Mr. Richard Johnson favoured us with some valuable information respecting the wire trades of France and England. He had now at work a machine which would produce 120 tons of Telegraph wire per week; and he felt convinced that notwithstanding the cheaper labour, and some other advantages in France, England was still able to compete successfully with the French manufacturers in that article.

Mr. Dickinson said the paper was a faithful and interesting account of the excursion; and he had much pleasure in moving a vote of thanks to the President for it.

Mr. Chattwood seconded the motion, which was carried.

The President, in reply, said they were all very much indebted to Mr. Greenwell for his excellent accommodation and provision; and also to the Rev. Mr. Lowther, who had allowed his agent to furnish them with a good deal of information.

Mr. Hull thought the paper a faithful description of what they had seen. He only regretted they did not go down to Bollington Brook, and see the New Red Sandstone at its junction with the great Red-rock fault. No gentleman would need to take it on hearsay that the rock was found in that neighbourhood.

In reply to a question from the President—

Mr. Hull said that to the best of his recollection there were pebbles in it.

Mr. Aitken called attention to four specimens of fossils, which he presented to the Society. He also communicated the following paper on the subject:—

BRIEF OBSERVATIONS ON THE

BONE BED AT LYME REGIS, AND THE FISH BED AT LUDLOW;

By John Aitken, Esq.

During a recent visit to Lyme Regis, I availed myself of the opportunity to inspect a part of the coast, a few miles west of that town; where a section of the group of beds which have recently—through the investigations and discoveries (principally of a palæontological character) of Mr. W. H. Bristow, Mr. Etheridge, and Mr. Boyd Dawkins, and at their suggestion—been classified as a separate formation, under the name of the "Rhætic or Penarth Beds." This series forms a connecting link between the subjacent Trias and the Lias above, and are considered as passage beds, partaking somewhat of the character of both, and exhibiting a gradual transition from one to the other. About the centre of the Rhætic Beds a thin stratum occurs, which, from the abundance of teeth, scales, and bones of fishes, and saurians found in it, has received the name of "Bone Bed." Two sections of this layer are exposed along the cliffs, west of Lyme Regis; but from the state of the tide at the time of my visit, I was unable to examine more than one of them. The band from whence the specimen on the table (No. 1) was obtained is a thin dark brown grey layer, ranging from half an inch to two inches in thickness. At the place examined, it was only visible in the cliff for a distance of four to six yards, being concealed on the east by *debris* from the fallen bank, and towards the west it appeared to thin out and become totally lost, no trace whatever of it being visible in the cliff beyond in that direction. It was situated about the centre of a series of beds of dark shale, of various hues, having one about a foot thick almost immediately above it, of a very dark colour, approaching to black. This

stratum, being much more continuous than the bone bed, is considered a good datum line; and is found of considerable service, in enabling the explorer to find the more obscure and intermittent band below. Above this dark layer are other beds of brown and grey shales, about six or eight feet of which are visible in the section. Subjacent to the bone bed are grey shales, which gradually take on a reddish hue as they descend; and at a depth of eight or ten feet become strongly tinged with red. In these shales, about six feet below the bone bed, a thin layer of flesh-coloured gypsum is intercalated, forming a broken irregular band of variable thickness. The matrix in which the numerous animal remains is embedded has a very conglomeratic character, and is principally composed of small rounded water-worn pebbles and grains of quartz, some iron, which, in many instances take the form of crystals of iron pyrites, together with a little lime; the latter in sufficient quantity to set up a feeble effervescence, on being treated with sulphuric acid.

On my return from the South of England I had, through the kindness of Mr. Lightbody, of Ludlow, an opportunity of examining *in situ*, at two places in the neighbourhood of that interesting old town, a remarkable bed—somewhat analogous in its appearance and composition to the formation just described. This being the zone in which the remains of vertebrate life (as fishes) first make their appearance, (so far as yet known) has given rise to the name of "Fish Bed," by which it is generally known. This thin and remarkable bed, it will probably be remembered, occurs near the top of the Upper Silurian formation, reposing upon the Upper Ludlow Rocks, and being superimposed by the fine yellow rock known as the Downton Sandstone. It is described by Sir R. I. Murchison, in his *Siluria*, as "a matted mass of bony fragments, for the most part of small size and of very peculiar character, these, with a few remains of shells and crustaceans, including the *Pteregotus Problematicus*, occur in a cement in which varying proportions of carbonate of lime, iron, and bitumen

are disseminated; some of the fragments of fish are of a mahogany hue, but others of so brilliant a black, that when first discovered they conveyed the impression that the bed was a heap of broken beetles." It will be noticed by examining the specimens on the table, how closely they answer to the description here quoted from the work of the eminent geologist; the exuvia forming so large a proportion of the composition of the rock as to constitute it an *Osseus breccia* set in a calcareous paste; fish teeth, spines, and scales, mostly in a broken condition, together with bits of bone and fragments of shells and crustaceans, appear to be the most prevalent forms. The fish bed is exceedingly attenuated, rarely exceeding one or two inches in thickness, and in some places diminishing to quarter of an inch, or even dying out altogether. In a few exceptional localities it has, however, been found to reach a depth of twelve or eighteen inches. At Ludlow, where the specimen (No. 2) was obtained, it ranges from a simple trace to one inch in thickness, whilst at Norton it attains the unusual development of at least eighteen inches; the specimen (No. 3) is from the last-named place. The thin bed at Ludlow is of a soft, crumbly character, and of a brown colour, and is not charged so profusely with animal remains as the thicker bed at Norton. At the latter place it is a hard grey matted mass of animal remains, held together by carbonate of lime, the defences of fish and crustaceans (some of which are beautifully fluted) and the palatal and other teeth present bright clean polished surfaces, and form striking objects in the slabs when broken open. The conditions under which this peculiar layer has been deposited appear to have been of a remarkably uniform character, for wherever it is found its similarity is striking and decisive; although it is so thin, it has a wide range. Professor Jukes mentions it having been traced at intervals over a distance of forty-five miles, from Pyrton Passage to Ludlow. Several places, at considerable distance from each other, are mentioned by Sir R. I. Murchison, where it has been discovered. It has come under my own personal observation at three places, viz:—on the flank of the Malvern Hills, on the

Herefordshire side; at Ludlow; and at Norton. The specimen (No. 4) was obtained from a thin layer in the Downton Sandstone, about four feet above the fish bed known as the Trochus Bed; in it the *Platyschisma helecites* occurs in great abundance.

The President said they were all much indebted to Mr. Aitken. It showed what Members of the Society could do in travelling about. Specimens and descriptions like these constituted a sort of information very useful to a Society like ours.

Mr. Greenwell thought these were similar fossils to those found in this neighbourhood in the Mountain Limestone.

The President said a great many of the fossils of this Bone-bed were most probably Rhætic and Triassic. Mr. Moore, F.G.S., of Cheltenham, had a fine collection of them, which he had chiefly obtained from fissures in the Mountain Limestone. He recollected many years ago stating that he found great difficulty in deciding where the Trias ended and the Lias began, and Sir Roderick Murchison told him to go down to Garden Point, on the Severn, and he would be able to decide directly. He accordingly went with Professor Harkness, and the Rev. Mr. Symonds, and they spent several hours there; but it certainly puzzled more than enlightened them. They could not tell; and he thought any one might go to that section and find it impossible to decide its age from the mechanical deposits. It would be only by the organic remains, and the question was whether these could make them altogether sure. When you examined that breccia bed it appeared to him that there might have been a great amount of strata removed, and we had nothing left of them except that thin bed of breccia.

Mr. Hull agreed with the President that it was extremely difficult, if not impossible, to tell where the Trias ended and the

Lias commenced. He came to the very same conclusion on visiting Garden Point and other districts—in fact, tracing the boundary between the two formations. In the first place, he might say that the difficulty was now increased. Formerly, it was supposed that certain fossil mollusca terminated at the base of these Rhætic beds; but some of them had been traced down through that series of grey marls which passed ultimately into the Red Marls; so that there it was a case merely of a passage—there was no physical break; and certainly, with regard to the mechancial character of the rocks, the passage was complete. There was nothing like a break, and he believed there was no appearance of unconformity, the truest test of a break, anywhere in England, or France, or Germany, between the Lias and the Keuper formation. The first case of unconformity and of denudation was at the base of the lower Keuper sandstone or waterstones; between that and the Bunter sandstone there was a very decided gap. This gap, which in Germany and some other countries was filled up by the Muschelkalk, was represented in this country by the denudation of the Gunter, and the unconformable superposition of the Keuper series, or lower Keuper sandstone.

The President said when he was a boy, and began to geologise, he saw a broad sharp line laid down in the books between the Lias and the Trias; but when he began to dig a hole in the boundary strata, near Gainsborough, he got into a lot of beds of yellowish clays, and he could find no such clear division.

Mr. Dickinson:—What can be the motive for attempting to make a distinction without a difference?

The President:—I think it is the desire of the mind to generalise a limited number of facts.

Mr. Hull believed there was a distinction and a difference, although there was no decided line. It was very advisable, very

useful, to have some sort of a division between the Lias and the Trias, notwithstanding that there was no physical break, and they could easily represent that on geological maps by putting in these Rhætic beds as a divisional series. He thought the more divisions they made in geology, the better they became acquainted with the physical character of the rocks. And then, if they recollected, that passing from the Red Marls into the Liassic series, they went through an extensive unfossiliferous deposit to one abounding in thousands of varied and beautiful character, there was very good ground, for this reason, for making a division. The circumstances of the time in which the two formations had been deposited had evidently been different.

The President observed that no doubt classification was very good, but it should adjust itself to new facts.

Mr. Dickinson said the arguments which Mr. Hull had brought forward in favour of different classification would all apply equally to the same definitions being observed with regard to the Coal-Measures. They had in the Coal-Measures just as beautiful transitions from fossil to nonfossiliferous beds, but yet it would be more confusing than advantageous to make these divisions.

Mr. Hull did not think the cases analogous at all. You found the same fossils throughout the whole of the coal-series from the bottom to the top, but you did not find them in them in the case of the Red Marl, and the Lias.

Mr. Plant thought the Survey Department did not acknowledge the Rhætic formation.

Mr. Hull replied that they not only acknowledged it but were busy mapping it.

Mr. Plant remarked that if this was the case, it certainly made

the discussion of very little value, because the interpellation of the Rhætic formation, which in this country was only represented by a thin band, must be looked for abroad for its typical development, where it reached a development of about 2,000 feet on the Rhætic Alps. And there was no doubt that the *avicula-contorta* band would always be a clear and distinct horizon, by which to separate the Lias and Triassic beds.

The President said the question was whether these grey marls could be connected with the Trias.

Mr. Plant said Mr. Hull had mentioned some mollusca that were found in the Liassic and Triassic beds. He was not aware of a single specimen of the kind.

Mr. Hull said the specimen had been found in the grey marls, which were now considered as Rhætic.

Mr. Aitken remarked that the Rhætic were supposed to terminate with the band of old shale.

Mr. E. Williamson then read the following paper, on the

GEOLOGY OF PARAHIBA AND PERNAMBUCO GOLD REGIONS

In the spring of last year, being attached to an expedition sent out to explore the new gold fields at the Caxoeira of Pianco, in the province of Parahiba, I had some opportunity for making a few observations on the geology of the two provinces of Parahiba and Pernambuco; these observations I now beg to lay before the

Members of the *Manchester Geological Society*, and I trust that with the aid of the section now exhibited, I may succeed in giving a fair outline of the geology of this vast tract of country, which, I believe, has never before been geologically explored.

The line of section is taken from Tambahi, a small fishing village on the Atlantic coast, through the city of Parahiba to the Minas das Caxoeira of Pianco, in the south-western extremity of the province of Parahiba. It is almost a direct line 300 miles in length across the strike of the strata.

The strata examined belong to rocks of widely different ages, viz: the Tertiary, Cretaceous, and Laurentian.

The post Tertiaries are represented by the coral reefs of the coast, and the peculiar deposits of ferruginous conglomerates and sandy marls which cap the lower hills of the coast, and flank the mountains of the interior. Of the coral reef I shall say nothing further, they have been so often and so well described. The ferruginous detritus is more interesting, it having been often mistaken by travellers as belonging to the New Red Sandstone, which it so greatly resembles, that on my first view, I also thought that they belonged to the New Red Sandstone.

From Tambalio to Parahiba the surface is covered by thick beds of ferruginous conglomerate, the accumulated *debris* from the gneissic and schistose rocks of the interior; in some places the conglomerate becomes so very coarse that it is wholly made up of water-worn pebbles, of quartz, gneiss, and the harder schistose rocks, cemented together by peroxide of iron. The size of the pebbles vary from that of a small nut to boulders weighing four to five pounds. This class is well represented below the baths at Tambalico; but as they approach the river towards Parahiba they gradually become mixed with finer and more argillaceous beds, until at last, at Santa Rita, a few miles out from Parahiba, they

have become divided into regular bands of marls, sands, and conglomerates.

At Pernambuco they form a series of low-lying, round-topped hills, the old coast line of a bay which once covered the plain on which the city of Pernambuco is now built. At Caxinga, a few miles out from Pernambuco, several fine sections of the sands and marls have been exposed by land-slips; the strata here bears such a strong resemblance to the New Red Sandstone of our own districts, that it would be impossible by colour and appearance alone to distinguish one from the other. In the interior, these sands and marls almost always occur where the Gneissic and Granitoid rocks are largely developed, as at Texeira, where Granitoid rocks abound, large quantities of brecciated conglomerates, sands, and marls are found flanking the mountains and covering the valleys.

Immediately underlying the ferruginous conglomerates of Parahiba, there occur beds of secondary limestone, having a strike nearly north and south, and dipping gently to the east. For the most part these limestones are silicious, though at intervals beds of nearly pure limestone and argillaceous bands occur; limestones of this character are common throughout the Brazils, and are always unconformable to the rocks which they underlie.

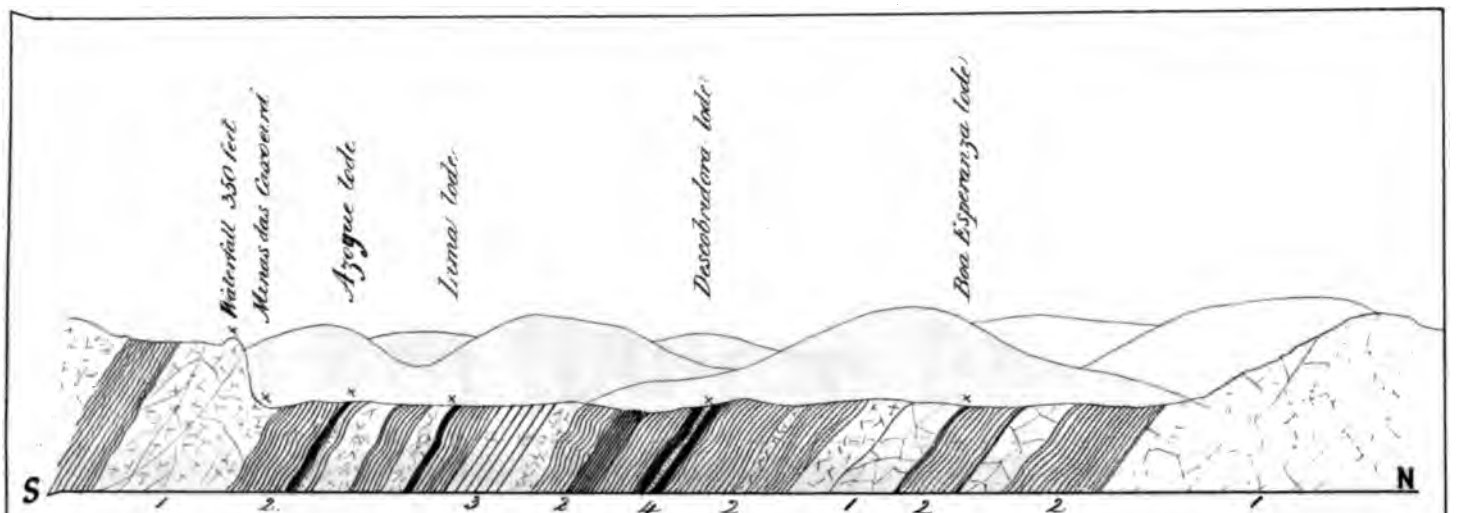
The secondary limestones which are found in the provinces of Ceara and Maranham are equivalents to our cretaceous rocks, and abound in fish remains; the limestones of Parahiba are also fossiliferous, though I was only able to obtain the cast of a fish tooth and a few small fragments of Estherea. Beds of limestone similar to the beds at Parahiba, and abounding in fish remains, occur about seventy miles south-west of the section at Minas da Caxoeira. I was told that beds of a similar character, lying nearly flat on the upturned edges of the gneissic rocks, were common in various parts of the two provinces of Parahiba and Pernambuco.

Laurentian Rocks.

These rocks, which occupy the greater part of the section and exist in such vast force throughout both of the provinces, are so distinctive in their character that there can only be one opinion as to their age. I greatly lament that my hurried journey up the country would not permit me to examine them more carefully and obtain the correct dip and strike of the different beds. On the section I have marked them all as dipping to the north; this I did so that I might have all the time of my journey to the mines in examining the lithology of the rocks, and reserved the observation on dip and strike for the return journey; but I was disappointed in not being able to return by the same route. I found afterwards, on my return journey from the mines to Pernambuco, that there were several anticlinals, which repeated the strata; this will account for the occurrence of rocks so similar in character at places so widely apart, as at Lagradoura and Texeira.

The first clear outcrop of the rocks, from Parahiba, occurs at Batalha on the river Parahiba; it is a hornblendic rock, with numerous small bands of quartz and feldspar much contorted.

Between the river Parahiba and Pillar a very coarse gneiss occurs, with large crystals of white feldspar and black mica; at Pillar the gneiss is interstratified with mica schists, generally fine in texture; at Mendonça, Mosheira and Inga Velho beds of similar character again occur, interstratified with gneiss; at the last-named place the schistose beds become more frequent, until at Inga the whole of the beds are micaceous and hornblendic schists. A little past Inga a hard close-grained gneiss rock appears; this flanks the mountains of Lagradoura, which chiefly consist of a white porphyroid gneiss, holding large cleavable crystals of pure orthoclase, interstratified with bands of syenitic and granitoid gneiss, much resembling granite. On the northern flank the hard close-grained gneiss rocks again occur.



SECTION ALONG THE VALLEY OF THE RIVER BRUSCUS SHOWING THE GOLD LODES. 6 MLES.

1. Syenitic Gneiss
2. Contorted Gneiss graduating into Mica Schists
3. Crystalline Limestone
4. Plumbaginous Schist.

Between Lagradoura and Campinas a well marked band—granitoid porphyry—occurs, standing out some 50 and 100 feet higher than the softer rocks which surround them; this porphyry contains large crystals of white orthoclase. At Campinas a series of micaceous beds occur, containing plates of mica. The largest was about two inches in diameter; but I was told that plates a foot square had been found; following this run of micaceous schist is a band of porphyry, in which large cleavable crystals of white orthoclase are embedded in a granular matrix of quartz and feldspar. I could distinguish no true bedding lines in this band, but from its dip and strike, and unbroken outcrop, I am inclined to think that it might be interbedded; the succeeding rocks are mica, schists and gneiss.

At Caximba Nova another band of hard granitoid rock occurs; following this there are a long series of mica schists and gneiss; near to Caracol occurs a series of black schists, alternating with bands of granular black rock; the schists are occasionally micaceous. At Caracol a small series of mica schists divide two broad bands of granitoid rock, in places these much resemble the true granites; overlying the upper one is a small band of hornblendic schist, this is followed by a long series of flaggy mica schists. At Carnauba these are succeeded by bands of hard, close grained gneiss; this flanks the mountains of Texeira, (rocks similar in character occur at Quemiada on the opposite flanks); the rocks of the Texeira mountains bear such a strong resemblance to those of Lagradoura, that I think they may be but a repetition of the same beds. Between Quemiada and the Minas das Caxoeira, another broad series of the same class occurs; the remainder of the rocks on the section are gneiss, alternating with bands of mica schists.

At various places on the section beds of quartz and quartzite, with plates of mica, were interstratified with the harder rocks; the beds varied from a few feet to two hundred feet in thickness; the smaller bands were often beautifully opalescent, the larger bands

granular or amorphous. Hæmatitic and titanic iron ores always accompany them.

On my journey from Parahiba to the mines, I failed to detect any beds of limestone interstratified with the Laurentian rocks, but I was informed that limestone interstratified with the rocks had been observed in other places where the limestones had not been hidden by the covering of ferruginous detritus.

The rocks at the Minas das Caxoeira, and the position of the gold bearing veins will be best understood on reference to the accompanying section, taken along the bed of the Bruscus River, for a length of about six miles.

At the southern extremity, divided by a band of softer rock, are two broad and well marked bands of syenitic gneiss, one of which forms the bed of the beautiful waterfalls of the Bruscus; underlying these is a series of schistose gneiss, and a narrow band of syenite; it is a bluish grey crystalline rock, and bears a strong resemblance to some of the Welsh upper Cambrian feldspar rocks. Succeeding these are the gold bearing series, which almost wholly consist of fine grained micaceous gneiss, passing imperceptibly into mica schists.

Crossing a bend of the river a little before reaching the Lima lode, a small band of dark brownish grey feldspar rock occurs, it is subtranslucent, and in places shows chatoyant colors; a little further on is a band of white crystalline limestone, containing hexagonal crystals of biotite; in the bed of the river it is small, but about a mile further east from this point, at a place called Piao, it is said to be a mile broad on the outcrop.

A little east from where the Descubridora lode crosses the stream, there occur a few beds of earthy plumbaginous schists, in which

are two lenticular veins of graphite; they seem to be of small extent and of a very indifferent quality.

At Cacimbinhas, a few miles further on than the Boa Esperança lode, another broad and well marked band of syenitic gneiss occurs, quite as large as that of the waterfalls.

The auriferous veins which traverse these rocks are very numerous, they appear as irregular lenticular masses, running parallel to the strike, often dipping between, but rarely cutting through, the beds. The matrix of the lodes is a coarse white semi-opaque quartz, containing small quantities of the arsenides and sulphides of iron, sulphides of copper, lead and zinc; most of the galenas contain antimony. The variety of minerals resulting from the decomposition of these ores are very numerous,—carbonate of zinc, carbonate and chloro-phosphate of lead, phosphate, arseniate and carbonate of copper, oxides of antimony and native sulphur are common in some of the lodes; sulphate of copper, sulphate and chromate of lead were more rare; native gold was sparingly scattered throughout nearly all the lodes, and in the Boa Esperança veins, grains of platinum were found.

The run of rocks in the valley of the Bruscus are very auriferous, and quartz veins abundant; and though the rocks are greatly contorted, no trace of a true fault can be found anywhere in the whole district; this singularity appears to belong to all the altered rocks which I examined in Parahiba and Pernambuco, for during a ride of 1000 miles I failed to detect any; it is to this want of true fractures that I ascribe the poorness of the quartz veins, there being nothing favourable to the concentration of the ores; the gold has been equally distributed throughout all the veins. It is well known to miners that no veins are so rich as those in which the

faces of dissimilar rocks are brought opposite each other on the walls of the vein.

On my journey from the mines to Pernambuco, I crossed the same run of rocks as those marked on the section, and during my ride was able to trace several anticlinals; this accounts for the vast extent of country covered by rocks of the same age.

About seventy leagues from Pernambuco I found a band of quartziferous porphyry, a specimen is exhibited; it has a compact base, composed of an intimate mixture of quartz and feldspar, enclosing crystals of orthoclase and grains of quartz.

Near to Jerimu there occur, within a few leagues of each other, two bands of crystalline limestone; one a narrow and highly crystalline band, the other a very broad band; in some parts this is micaceous, but none of the beds are so highly crystalline as the small band.

The country between Jerimu and Pernambuco bear a strong resemblance in character to those marked on the section between Parahiba and Campinas.

The whole series of these rocks agree in every respect with the characteristic features of the Canadian Laurentian rocks, as given by Sir W. E. Logan, viz:—

I. The total absence of anything like argillite or clay slate.

II. That nothing corresponding to slaty cleavage has ever been remarked.

III. That the lamination of these masses is apparently in every case coincident with, and dependent upon the original stratification of the sedementary layers.

A vote of thanks to Mr. Williamson, for his paper, was passed.

The President said they were all indebted to Mr. Williamson for giving them so lucid a description of what he had seen in South America. He would ask what thickness the Laurentian rocks were.

Mr. Williamson said they were undefined; but they must be of vast thickness, for he rode 300 miles across the strike of them, and he could not say how much further they went.

Mr. Dickinson asked Mr. Williamson how he accounted in the section for these rocks all being placed on their end, instead of being horizontal, and without some great breaks taking place.

Mr. Williamson said he thought the rocks were contorted, in a similar way to the ideal section of the geology of the Amazonas, and that the tops had been denuded off.

Mr. Dickinson asked if Mr. Williamson had seen any of these contortions.

Mr. Williamson said he had; but having only fifteen days to go over 300 miles he could not examine them very closely. He had intended returning by the same route, for the purpose of making a more complete investigation, but his intention was frustrated.

Mr. Plant thought it was valuable to have a record of what Mr. Williamson had seen. Professor Agassiz had lately given general views on the geology of Brazil, and it was interesting to see how the examination of Mr. Williamson coincided with what the Professor had laid down. Mr. Williamson's section showed a great series of contorted metamorphic rocks, which were regarded as Laurentian, and formed the fundamental rocks of the whole Amazon valley, in which Parahiba was included.

Mr. Williamson having answered several inquiries respecting his diagrams, the proceedings then terminated.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 8.] VOL. VI. [Session 1866-67.

The Monthly Meeting of the Members of the Manchester Geological Society, was held in the Museum, Peter Street, on Tuesday, May 28th, 1867.

E. W. BINNEY, Esq., F.R.S., F.G.S., President, in the Chair.

Mr. G. C. Greenwell, F.G.S., submitted a specimen of *Prestwichia*, found in the Coal-Measures of East Somersetshire, with reference to which he read the following paper:—

ON PRESTWICHIA,

FOUND IN THE COAL-MEASURES OF EAST SOMERSETSHIRE;

BY G. C. GREENWELL, F.G.S.

The specimen exhibited was found by Mr. G. Edward Feare, of Camerton, near Bath. It is seen to be in a piece of shale which was broken from a large mass of the same material, lying in the spoil heap of the Camerton Colliery, about three years ago. Mr.

Feare says, "the shale is to all appearance, a portion of the roof of the Great Vein," which is the uppermost workable seam of coal of the highest (or Radstock) series of coal seams of the East Somersetshire coal-field.

I have shewn the specimen to Mr. Robt. Etheridge, F.G.S., (Museum of Practical Geology, Jermyn Street, London,) who has kindly sent me the beautiful drawing of it, attached to this paper, with the following remarks:—"I send you both drawing and "specimen of *Prestwichia rotundata* (*limulus rotundatus*) from the "Bristol coal-field, and you will see that upon the *Carapace* (*Cephalo-* "*thorax*) there are small rounded bodies: these are *Spirorbis carbon-* "*arius*; so that you now have two genera from these beds, both "marine, though either could, and perhaps did, live in brackish "water. There is no doubt but that it is the *Prestwichia* (*Limulus*) "*rotundata* of Prestwich, but it materially differs from the true "*Limulus* (living); hence the generic change to *Prestwichia*. This "genus differs from *Belinurus* which has moveable thoracic segments "and anchylosed abdominal ones: whereas in *Prestwichia* (*Limulus*) "the thoracic and abdominal segments are not divided: the former "(thoracic) appear anchylosed.

"Head shield—a *cephalo-thorax*, *quadrato-rotundate*, truncated in front, expanded at the sides, and possessing postero-lateral horns or spines.

"Thoracic segments, 5—the axis appears to have borne tubercles or spines.

"Pleuræ—— appear to have a membranous extremity, apparently delicately spined.

"Telson —— a long spine."

Mr. Etheridge further observes:—

"It is well known that the fossil forms of this group were con-
"temporaneous with the group of *Trilobites*, to which they bear
"strong resemblance and close affinity: indeed many species of
"*Trilobites* were furnished with long caudal appendages, (*Ex.*
"*Phacops longicaudatus*) and prior to the development of the Telson
"in *Limulus* and *Prestwichia* the resemblance must have been
"striking, and especially so in one species, *Limulus Trilobitoides*,
"from the ironstone of the Coal-Measures of Coalbrook Dale,
"which is strongly trilobed and equally remarkable for the spiniform
"prolongation of the lateral angles of the *cephalo-thoracic* buckler,
"and many other characters in common with the *Trilobites*. The
"*Limuli* occur in a fossil state in the coal formation of Staffordshire,
"Derbyshire, Lancashire, and Somersetshire, and in the Oolitic or
"Jurassic Limestones of Pappenheim and Solenhofen, as well as
"in the Muschelkalk, as observed by Count Münster. The
"*Limuli* of the Coal-Measures of Coalbrook Dale occur in the
"Pinney stone (*argil. Ironst.*)"

The position of *Prestwichia* in the Animal Kingdom is as follows:

CRUSTACEA.

Order, Merostomata (Dana, 1852.)

I. *Sub-order Eurypterida*, (Huxley, 1859.)
II. *Sub-order Xiphosura*, (Gronovan, 1764.)
1. *Belinurus* (König,) Baly ..... 4 species.
2. *Prestwichia, nov. gen.*..... 2 species.
1. *P. Anthrax* (Prestwich.)
2. *P. Rotundata* (Prestwich.)
3. *Limulus* (Müller) .....15 species.

(See a paper by Mr. Woodward, F.G.S., F.Z.S., of the British

Museum, on the "Structure of *Xiphosura*," Quarterly Journal Geological Society, No. 89, p. 28.)

The specimen of Shale containing the *Prestwichia*, contains also an impression of the *Pecopteris Bucklandii* (Brongniart,) and the association of the land plant with the marine animals may give rise to some speculation.

The thanks of the Society were voted to Mr. Greenwell for his paper.

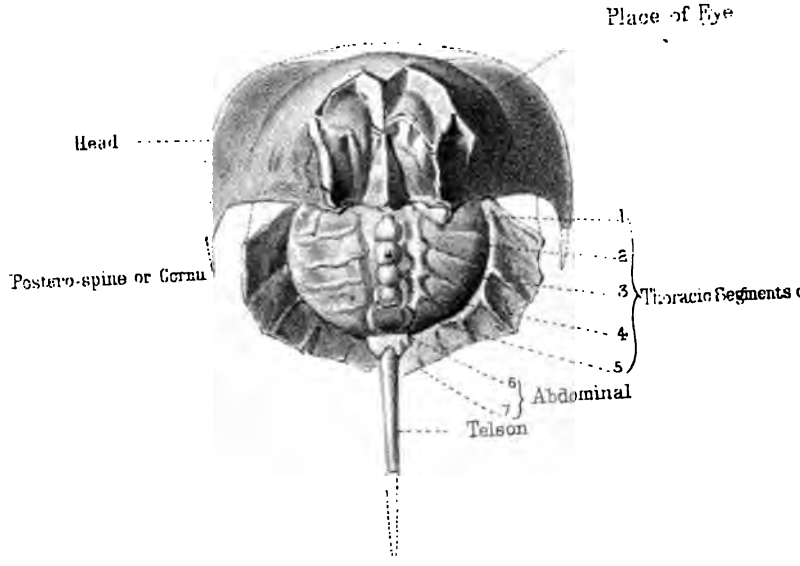
The President:—The *Spirorbis carbonarius* is very common in the Coal-Measures, we find it on plants, shells, and animals; as to the plants found with the fossil, it does not follow that they grew on land at all. Such ferns might have grown on trees, and fallen into the water.

Mr. Greenwell:—Do you suppose from the number and character of the plants associated with the coal seams, that coal is a marine formation?

The President:—In my opinion nearly all the plants which formed the coal grew in water. That was also the opinion of many eminent geologists.

Mr. Aitken:—There are geologists who do not adopt that view. They contend for the land formation of coal.

The President:—All I can say is that they must bring evidence of dry land. Those who contend for the land plants must bring their proofs. M. A. Brongniart says they are chiefly aquatic plants. What I have seen of these plants in examining their structure, confirms my opinion that they are water plants; and when we see them associated with the *Nautilus*, and such shells,



PRESTWICHIA ROTUNDATA.

we cannot have much stronger evidence. Many of the so called land shells and insects found in the Coal-Measures may have lived on the tops of plants growing out of water.

IMPROVEMENTS IN THE SAFETY-LAMP.

Mr. J. J. Horsfall:—I wish to bring before the Members a new and improved plan for fastening the locks of safety-lamps. The lock shuts with a self-acting opening, and is opened with a screw-key. It is impossible to unlock the lamp except with a key.

The President:—Supposing a miner did get a key, would the lamp go out if opened?

Mr. Horsfall:—This lamp would not go out.

The President:—Generally speaking, what one man can lock another man can unlock.

Mr. Horsfall:—Another good principle in this lamp is, that though it takes a longer time to fill, and to that extent is objectionable, it is impossible to get the oil out of it. I have here, also, another system. In this lamp you have to extinguish the light before you can pull the lock off. The wick acts as the lock in this case. You cannot take the top off without drawing down the wick.

Mr. Dickinson:—How do you get over the difficulty in cases where a man elongates the wick to allow for the unscrewing and undrawing?

Mr. Horsfall:—The elongation of the wick would not serve any purpose, as it must still be put out before being unlocked.

The President:—The use of the old pricker seems very awkward. It appears to be considered an indispensable part of the Davy lamp. I don't see why they cannot use the rack. Do not you think it possible, Mr. Dickinson, for 500 colliers putting their heads together, to devise some way or means of opening that lamp without putting out the light?

Mr. Dickinson:—I can scarcely say.

Mr. Higson:—I don't dislike the principle, though there is that objection of pushing up the wick.

Mr. Horsfall:—Still, by pushing up the wick you cannot pull the top off. You may push the wick bodily out, but I don't see what benefit there can be in doing that, as it would put the light out. The expense of a lamp of this kind would be about three shillings and sixpence.

GLACIAL MARKINGS IN SALFORD.

Mr. Plant:—Mr. President, the matter which I wish to introduce is, I conceive, one of considerable interest to the Members of this Society; because I have repeatedly heard, it is very rarely indeed, that there have been observed in this district any authentic instances of glacial scores or markings on the New Red Sandstone. It may, therefore, not be uninteresting to state, that there is one exposed at the present time at Ordsall Old Clough. The extent of the exposed surface is about twelve feet square, and the strongest markings are fully four inches deep. It underlies the deposits of boulder clay or till, which have been excavated some twenty feet deep in making a new street in continuation of Oldfield Road.

The ice-scored surface of the New Red Sandstone (Pebble beds) comes to the level of the new street at the place, and the markings will soon be obliterated; although this afternoon, when I saw them they were very fresh and beautiful.

The President:—Some years since, Mr. Morton, of Liverpool, sent to the Society a description of the Triassic rocks near Liverpool, which he had noticed in the neighbourhood of West Derby, and also on the other side of the Mersey, near Flaybrick. In this instance, as Mr. Plant has observed, there were great ruts, and scorings ten or fifteen feet long, and four or five inches deep.

Mr. Plant:—The men, when they came upon them, thought they were stone pipes lying below the boulder clay.

The President:—I am sure we are all much obliged to Mr. Plant for his communication, and any gentleman has now an opportunity of judging of the matter for himself, by going to the place and examining the markings.

Mr. Aitken:—I have to submit to the meeting a specimen of bullion taken from the Gannister Mine. I thought, when the specimen was presented to me it was a fruit of the species *Trigonocarpon*; but I have reason since then to doubt its being fruit. From the observations of the President, it is not at all improbable that it is a washed piece of wood, although it has very much the appearance of a nut or fruit.

The President:—Mr. Aitken shewed the specimen to me and I was anxious to see if it were a fruit. I had small ones in my possession before, from near Oldham. They assume an oval-shaped form, and generally, I think, they are portions of fossil wood that has been calcified, and a portion of it afterwards decomposed. There are

found amongst these bullions many specimens of *Trigonocarpon*, but they have all a thick coating, or shell which I don't see either on Mr. Aitken's specimen, or on any of mine.

Mr. Aitken :—These bullions are charged with vegetable stems.

The President :—They are samples of the vegetable matter forming the coal in which they are found. All of them show structure. Specimens of *Trigonocarpon* seem to have been full of starch, something like the kernel of a nut.

Mr. Plant :—I think, Mr. President, your opinion is quite correct. It is only a piece of wood.

The President :—It can only be thoroughly proved by cutting the specimen.

Mr. Aitken :—I will have it cut and put under a microscope.

Mr. Plant :—There is a parallelism in these lines which we never see in the fruit, which makes it very distinct.

The President :—Most assuredly the specimens of *Trigonocarpon*, which Dr. Hooker and myself described some years ago since, were obtained from these very nodules.

Mr. Higginbottom, Junr., read the following description of

THE ASTLEY DEEP PIT,

NEAR ASHTON-UNDER-LYNE.

The new pit which has recently been sunk to the Black Mine, on the Dukinfield Estate, near Manchester, is of a total depth, from

the surface of the ground to the bottom, of 686½ yards. The general diameter is twelve feet, with the exception of a length in the middle where it has been widened to twelve and a half feet, to facilitate the passing of the chairs; excepting also a few yards of the pit bottom, where it gradually increases to nineteen feet two inches. In sinking the pit itself 320,931 cube feet of material have been excavated, and 10,584 more have been cut out for mouthings. Of the total depth of the pit 211 yards have been sunk through rock; 443½ through shale; and the remaining thirty-two through seams of coals. Of these seams there are twenty-six of more than a foot in thickness, of which fifteen with an aggregate thickness of fifty-eight and a half feet have been worked at different places in the neighbourhood, and may therefore be considered to have a present commercial value. The shaft, with the exception of forty-two yards where it is tubbed with cast-iron segments, is walled with a nine inch wall of arch bricks, stiffened at intervals by stone rings, eighteen inches on the bed and twelve inches thick, of which there are eighty. Altogether 7308 cube feet of stone and 750,000 bricks have been used in the shaft, exclusive of those employed in the mouthings, &c.

In sinking, water was met with at the following depths: at 181 yards from the surface forty gallons per minute; at 240 yards, thirty-five gallons; at 358 yards, fifty-two gallons; at 413 yards, thirty-three gallons; and at 590 yards, five gallons; making a total of 165 gallons per minute. This water is raised to the surface by means of seven lifts of plunger pumps, of these the four upper are twelve inches diameter and the three lower nine, seven, and six inches diameter; they have all a stroke of eight feet. The four heavy lifts average above ninety yards in length each, and are arranged alternately on opposite sides of pump rods; each stroke of the pump raises thirty-nine gallons, and consequently the engine has to run at an average speed of four and a quarter strokes per minute for the twenty-four hours. At full speed the engine would make from eight to nine strokes per minute. The pump trees are

thirteen inches internal diameter, and are for the most part of wrought iron, the plates of which they are made increase somewhat in strength towards the bottom of the lifts. The total weight of the pumping rods, joint-plates, clumps, bolts, plunger-poles, &c., is eighty-five tons; of this weight forty tons are balanced at the pit top by a loaded balance beam, the remaining forty-five tons being sufficient to overcome the weight of the column of water and the friction of the plunger-poles, &c. The pumping apparatus occupies in the pit an area of twenty-nine square feet, having eighty-four square feet for winding.

The conducting rods are of pitch-pine, attached to bearers of the same wood, which are supported on cast-iron boxes let into the walling of the pit. The horse-trees are also for the most part of pitch-pine, as are the pump-rods, which are fifteen inches square at the top and diminish gradually downward to ten.

The total amount of timber used in the pit is 5882 feet.

The pumps are worked by a side-lever Cornish engine, with a seventy inch cylinder, eight feet stroke. The steam is supplied by three boilers, thirty-four feet long, six feet six inches diameter, with an ordinary working pressure of steam of twelve pounds to the square inch. The winding-engine cylinder is sixty inches diameter, with a stroke of seven feet. The winding drums are twenty-four feet two and a half inches in diameter, and the whole weight of crank, crank axle, and drums is fifty-three tons. To one of the winding drums a brake drum is attached, which is acted on by a steam-brake of great power. Besides the winding drums there is on the main shaft a balance weight-drum of six feet eight inches in diameter, to which is attached a balance weight of five tons.

The engine is capable of running twenty-five strokes in the minute, and consequently of raising the load in the pit at the rate of about twenty-one miles an hour. Allowing for the time

lost in hooking on and taking off, the engine is able to rise 600 tons of coal in ten hours. The winding ropes are of wire, 4½ inches broad by 1⅛ thick at the top, tapering downwards to 3½ broad by ¾ thick. They weigh four and a half tons each, and the breaking strain at the thin end is thirty tons; the actual working load is three and a quarter tons, which is made up as follows: the chair, which is constructed to carry four double load tubs, and weighs sixteen cwt., four tubs which weigh seventeen cwt., and the coal weighing thirty-two cwt., making in all sixty-five cwt. The winding ropes pass over pulleys fifteen feet in diameter, which are supported by the head gear at a height of fifty feet above the landing stage.

Besides the engines described, which were erected by Messrs. Fairbairn, of Manchester, there is on the ground a high-pressure capstan engine of thirty-horse power, by Messrs. Garforth, of Dukinfield. There are now eleven boilers actually in use, and room in the boiler house for two more boilers. There are seven lifts in the pit, all being rams, the longest lift being 150 yards. There is also a small low-pressure engine, which drives a circular saw and drilling and punching machines, and supplies generally the power required in the workshops.

The workings are aired by the assistance of the dumb-drift, which is driven up from a counter level to No. 2 shaft, rising two feet to the yard. The dumb-drift is ten feet diameter, which forms an area of 78½ feet, and enters the upcast shaft at 600 yards from the surface; the furnace drift is twenty-five yards from the pit bottom, being sixty-one and a half yards below dumb-drift. Careful observations, made during the sinking of the pit, have shown that the temperature of the strata increases with tolerable regularity from 51° at a depth of 6 yards, to 75¼° at a depth of 686½ yards.

The temperature on the pit top, this day, May 28th, 1867, at 11

o'clock, a.m., was 58°, at the pit bottom 64°; variation 6°; in the return air roads, when the air has passed round the workings, and done all its work previous to making its exit into dumb-drift, is 71°, variation from pit bottom 7°.

The remaining 205 yards have been sunk by the Dunkirk Coal Company.

We have now an incline at work at the bottom of Astley Pit, which is 250 yards down, lying at an angle of one foot to the yard, making the total perpendicular depth from the surface to the lowest point, 770 yards.

A vote of thanks was unanimously passed to the writer of the paper.

Mr. Greenwell:—I have observed at Monkwearmouth, at a depth of 580 or 590 yards, the temperature has been as high as eighty-six degrees; but it appears that the temperature at Dukinfield, where the depth is more by 100 yards, it is only seventy-one degrees. I think if you take the temperature at the surface, (fifty-eight degrees) and if that is deducted from the seventy-one degrees at the bottom, and that distributed over the depth, it will be found that that will make one degree for a greater length than is usually accepted. It rather agrees with an idea upon the point which has occurred to me; and that is this:—that if you take pits of moderate depth, say forty, or fifty, or sixty, or seventy fathoms, you will find an increase of temperature of one degree for every forty-five to fifty feet. But, if you go deeper, say 200 fathoms, you will find an increased average of a great many more feet for the increment of one degree. I think this is fully corroborated, as far as one example may corroborate anything, by Dukinfield.

The President:—A great deal has been said about the temperature of the earth, and both on the Continent and in this country there have been a great many observations upon it, and each particular observer adheres to the results of his own observations, and wants to make the earth hotter by a degree for so many feet These observations are very different, and are likely to be very different, because many of them are not made with the care they ought to be. At any rate they do not point to any general conclusion. We find that in Cornwall and Devonshire there is one scale of increase of temperature; in Durham another; and in Cheshire another. This is probably due to the way in which the observations have been made. Observations of temperature, with a delicate thermometer, require a great deal of care. When there are a great many men in a pit, and a current of cold air, and when, as suggested by Mr. Livesey, the decomposition of pyrites liberates heat, the conditions must be very different. Then we all know that in deep mines gas is pent up in the coal, and exercises considerable force in liberating itself. The force is so great that it has forced the face of the coal right off. An instance occurred at Ebbw Vale lately, where thirty tons of coal were said to have been forced off by the pressure of the gas to get out. When the gas thus diffuses itself through the works it lowers the temperature of the mine. On looking at all the observations, and the different results, we must come to the conclusion that we have not an absolutely correct rule as to the increased ratio of the temperature of the earth.

Mr. Dickinson:—In the sinking of this pit a most careful series of experiments was made as to the temperature. If a copy of the results were appended to the paper, it would be very valuable. Everything that human skill and care could do was done.

The President:—Dr. Fairbairn has published them. They were taken under Mr. Astley's directions and have been published.

Mr. Dickinson:—They would be useful if added to this paper.

Mr. Higson :—You will find that pits of the same depth differ in different parts. The upper part of the middle coal or greater field is never at the same heat as the lower. You will find a greater increase of heat down the Astley Mine, at 300 yards, than you find at 300 yards, where there is the beginning of the middle coal-field.

The President :—That is an interesting fact.

Mr. Greenwell :—It is clear from that that you cannot take an increased ratio of heat from an increase of depth, if you have a greater amount of heat from one description of strata than from another. It is due to other causes than the depth of the earth.

Mr. Evans :—At five successive dates I took the temperature at the top and the bottom of our pit, and I found that it differed from seventy and a half degrees at the bottom to fifty-nine and a half degrees at the top. This varied every day from five degrees to ten and a half degrees.

Mr. Dickinson :—That is quite what I should have expected; that the increase of the temperature at the bottom of the pit would vary with the height of the barometer at the top.

The President :—Mr. Dickinson, have you anything to communicate to us respecting the great outburst of gas at Ebbw Vale?

Mr. Dickinson :—I have only seen the account given before the Committee of the House of Commons, and that which appeared in the Newspapers, as well as in a private letter. But they are things which occur on so many occasions that I don't think there is anything very unusual in it.

The President :—But this seems a very large outburst at one time.

Mr. Dickinson :—The quantity gets exaggerated.

The President :—I heard that thirty tons of coal were forced from the face of the mine simply by the pressure of the gas, and that there was 200,000 feet of gas instantly discharged into the workings.

Mr. Dickinson :—It is difficult to make an accurate calculation of the quantity of gas coming off in this way.

The President :—I recollect ten yards of strata being lifted in the course of sinking a pit, when a deep seam of coal was first reached.

Mr. Evans :—Ten perpendicular yards! That is more than lifting thirty tons of coal.

The meeting then terminated, with a vote of thanks to the President.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 9.] VOL. VI. [Session 1866-67.

The Monthly Meeting of the Members of the Manchester Geological Society, was held at the Museum, Peter Street, on Tuesday, June 25th, 1867.

E. W. BINNEY, Esq., F.R.S., F.G.S., President, in the Chair.

Mr. Aitken submitted for the inspection of the Meeting, a Stone Hatchet, which had been discovered in the gravel in the valley of the Don, near Doncaster. He was not able to make out the character of the stone, but it seemed to be very white, fine, and hard. It was a good specimen of the early stone implements.

The President:—It is very similar to the soft hone stones. It is a nicely-formed weapon, and seems to be one of the implements belonging to the latest stone age.

Mr. Aitken:—The hatchets were fastened on split sticks with the intestines or sinews of animals.

The President:—When we look at savage nations now, we shall find that the mode of fastening stone implements in wooden handles is very similar to that practised in ancient times. These hatchets are generally found in the beds of rivers, or in low holms adjoining rivers, or where rivers have formerly flowed. They generally selected a stone that was moderately tough and hard; and they seem to have been remarkably good judges of these stones, some of them being brought from a considerable distance. In some cases they seem to have travelled hundreds of miles for the purpose of selecting them.

Mr. Parker exhibited some specimens of Sandstone and Magnesian Limestone. He said that he had found them in the till just above the prison. Two of them were evidently the Permian sandstone.

The President:—This is a very good specimen of limestone, showing *Schizodus obscurus* and *Gervillia antiqua*, and other shells characteristic of the magnesian limestone formation. This deposit seems to have been far more extensive than it is now. The specimens come out of the brick clay or till which is found on the rising ground on the outside of the city. Remarkably good specimens of Permian rocks are often found in this deposit.

The following communication was then read: "On a Lower Greensand Phosphatic Deposit recently discovered at Upware;" by Mr. Norman Moore. Also, a paper "On the Fish Remains and Ichthyolites of the Lancashire Coal-Field;" by Mr. John Plant, F.G.S.

The Meeting then terminated with a vote of thanks to the Chairman.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 1.] VOL. VII. [Session 1867-68.

The Annual Meeting of the Members of the Manchester Geological Society, was held at the Museum, Peter Street, on Tuesday, October 29th, 1867.

E. W. BINNEY, Esq., F.R.S., F.G.S., President, in the Chair.

The President said, our meeting to-day is the annual one, which is called for the purpose of receiving the reports of the Council, the Curators, and the Treasurer, and for the election of the officers for the ensuing year. Last year, when I had the honour of occupying this chair, I stated that the relations with regard to the Natural History Society were very uncertain; and that we did not know what we should have to do for a place of meeting and a museum. During the past year many attempts have been made to do something with the property of the Natural History Society, but we were obliged to wait, and at the present time the matter appears just as unsettled as it was last year. The difficulties the Society is under with regard to a place of meeting and the museum were mentioned at the time you did me the honour of appointing me President two years ago. So far as we are concerned we might continue to go on without a museum; we could find a place of meeting; but really

if we are to keep up our museum, we require a building; and whether the Members and Friends of the Society will be able to procure one, I am not able to say; but for the last two years we have had brought before the Society the difficulties in which we are placed. We came to this Society because we were offered very reasonable terms, as no rent was charged, and ample accommodation was afforded. At that time it was supposed that the Geological Society would not last many years, and when defunct that its collection of specimens would be a very acceptable addition to the Natural History Society's Museum. Now, however, it appears that the Natural History Society is prepared to leave our Society alone to find a resting place for itself. It is intended at the close of this year that something definite shall be adopted, most probably to give their property to Owen's College. Until that time we can do no harm in remaining as we are; and at present we have ample accommodation. During the past year we have had a considerable accession of new members; but we have lost several by death. Amongst the chief I may allude to Mr. Joseph Whittaker, of Burnley,—a gentleman whom we hoped to have been of great assistance to this Society. He was one who had cultivated Geology with great ardour for a number of years, and I must say that a more patient and truthful observer I never met with. He was a man with extraordinary powers of observation, and remarkably sound judgment. He had proposed to investigate the Millstone grits and the Limestone shales of his district; and he was engaged in that work at the time of his death. Unfortunately he died in the midst of his labours, and though he has left some splendid fossils, I doubt whether his observations on the Limestone shales and grits were completed so far at the time of his death as to be ready for publication. He was, probably, the most cautious man I ever met with. He would go over and over again his investigations to see whether he was positively certain. I must say that for a man so young—he was only 39 years of age—I had hopes, though he had been ailing for some time, that he would have survived. Another gentleman whom we have lost is Mr. Hodgson, of Liverpool formerly,

but he afterwards lived near Whalley, who was a regular attendant at our meetings. Having made these remarks, I think it better to proceed to the business of the day. The first thing to which I will direct your attention is the Report of the Council.

Report of the Council.

At the expiration of their year of office, your Council beg to present to the Members of the Society a report of the proceeds during the past year, together with the Treasurer's account of the receipts and disbursements on account of the Society, a list of the donations to the Library and Museum, and a list of papers read during the session:—

During the past year 19 new Members have been elected, 6 have retired, and 4 have died; and the present number is 192.

Your Council have again the satisfaction of announcing that the Balance Sheet is favourable, the balance in hand being £193 10s. 2d., against £144 18s. 5d. at the commencement of the session.

Nothing has been done to alter the relations between the Geological and the Natural History Societies.

Four excursions have been made by the Members during the past session. One from Stubbins to Bacup; one from Disley to Poynton; one from Chatburn across Pendle Hill to Nelson; and the last from Summerseat to Rawtenstall. At the first of these excursions the Members were the guests of Mr. Thos. Brooks; the second of Mr. Greenwell; the third of Mr. Chaffer.

The following papers have been read to the Society:—

List of Papers Read, 1866-67.

1.—"Account of the Excursion to Bacup and Todmorden."—By Mr. John Aitken.

2.—"On the Upper Coal-Measures of England and Scotland."—By Mr. E. W. Binney, F.R.S., F.G.S.

3.—"On the Permian and Triassic Strata of the North-West of England and West of Scotland."—By Mr. E. W. Binney.

4.—"Account of the Excursion from Stubbins to Bacup."—By Mr. John Aitken.

5.—"On the Fish Remains and Ichthyolites of the Lancashire Coal-field."—By Mr. John Plant, F.G.S.

6.—"On the Existing Methods for Extinguishing Fires in Coal-Mines."—By Mr. James Atherton.

7.—"Notes on the Excursion to Disley."—By Mr. E. W. Binney.

8.—"Observations on the Bone-Bed at Lyme Regis, and the Fish-Bed at Ludlow."—By Mr. John Aitken.

9.—"Geology of Parahiba and Pernambuca Gold Regions."—Communicated by Mr. Ezekiel Williamson.

10.—"On Prestwichia, found in the Coal-Measures of East Somersetshire."—By Mr. G. C. Greenwell, F.G.S.

11.—"Improvements in the Safety-Lamp."—By Mr. J. J. Horsfall.

12.—"Glacial Markings in Salford."—By Mr. John Plant, F.G.S.

13.—"On the Astley Deep Pit."—Communicated by Mr. Higginbottom.

14.—"On the Lower Greensand Phosphatic Deposit recently Discovered at Upware."—By Mr. Norman Moore.

The Donations to the Society—both to the Library and Museum—are numerous, but it will not be necessary that they should be read.

The Treasurer presents the usual balance sheet, and reports that the funds of the Society are in good order, the expenditure on the reports having been reduced. There is an arrear of subscriptions by 39 Members amounting to £107 10s. 0d., and of this sum

£60 is owing by 10 Members. It has been suggested that those who owe for four years and upwards shall be struck off the list of Members; but the Council have thought it better to give them a month's notice before they executed summary judgment upon them.

The Report of the Curators,

of whom I am one and Mr. Ormerod the other, was, that during the past few years they had had liberal donations given to the Society; but little had been done in the way of arranging them, because of the uncertain tenure of the Society in this building.

The Treasurer then read his report, as follows:

Report of the Treasurer.

The Treasurer presents his usual balance sheet, and reports that the funds are in good order. The expenditure on the reports having been reduced, he recommends that a sufficient part of the balance should be applied in the purchase of an additional £100 of Birkenhead Stock guaranteed by the Joint Companies, in the value of two Trustees as before. He further reports that there is an arrear of £107 10s. 0d. on the list of subscriptions, owing by 39 Members, and of this £60 is owing by 10, who owe four years and upwards each; and he proposes and recommends that the annual meeting should authorize him to strike these 10 names off the list of Members.

The adoption of the report was unanimously agreed to.

The following Gentlemen were then elected as officers for the ensuing year. (See page 7.)

MANCHESTER GEOLOGICAL SOCIETY.

BALANCE SHEET, 1867.

Abstract of Receipts.

1866.	£	s.	d.
To Balance brought down	144	18	5
„ Subscriptions, 866-67	118	0	0
„ Half-Subscriptions, 1867	3	10	0
„ Arrears of former years	6	0	0
„ Interest from Bank	6	13	2
„ Dividends	7	17	4
	£286	18	11

Abstract of Payments.

1867.	£	s.	d.
By Library	1	19	3
„ Fossils Purchased	1	0	0
„ Reports of Meetings	40	4	3
„ Reporters	9	9	0
„ Printing and Stationery	4	7	9
„ Postages, Delivery of Proceedings, &c.	24	7	0
„ Collector's Commission	6	7	6
„ Gratuity to Mr. Parker	5	5	0
„ Insurance, two years	1	9	0
	£93	8	9
Oct. By Balance in Bank £156 3 5			
„ „ with Treasurer 37 6 9	193	10	2
	£286	18	11

Oct., 1867. To Balance brought down £193 10 2.

Examined and found correct,
29th October, 1867,
ROBERT PHILIPS GREG, Auditor.

HENRY M. ORMEROD, Treasurer
26th October, 1867.

OFFICERS AND COUNCIL FOR 1867-8.

President:

G. C. GREENWELL, Esq., F.G.S.

Vice-Presidents:

JOHN AITKEN, Esq.
E. W. BINNEY, Esq., F.R.S., F.G.S.
JOSEPH CHATTWOOD, Esq.
ANDREW KNOWLES, Esq.

Treasurer:

HENRY MERE ORMEROD, Esq.

Auditors:

R. P. GREG, Esq., F.G.S. | R. D. DARBYSHIRE, Esq., F.G.S.

Honorary Secretaries:

JOHN EDWARD FORBES, F.G.S. | JAMES ECCLES, F.G.S.

Honorary Curators:

E. W. BINNEY, Esq., F.R.S., F.G.S. | H. M. ORMEROD, Esq.

Other Members of the Council:

Mr. John Ashworth,
„ Charlton,
„ Dickinson,
„ Eskrigg,
„ Hardwick,
„ Horsfall,
Mr. R. Johnson,
„ John Knowles,
„ R. M. Knowles,
„ C. Livesey,
„ T. Livesey,
„ Wilde.

Representatives of this Society at the Council Meetings of the Natural History Society,—E. W. Binney, Esq., F.R.S., F.G.S.; and Mr. Alderman Harvey.

The President:—I am exceedingly obliged to you for th attention you have given to me while I have occupied this chai This is the last time, probably, that I shall have the honour c appearing as your President; and I beg leave to thank you for th assistance you have given me in enabling me to carry on th business of the Society. The President is of little use unless he i backed by an efficient Council, and I thank those Gentlemen fo the assistance they have given me during my occupation of th office. I can speak so far for the Council generally, that we hav done the best we could for the interests of the Society. We ma not always please everybody, but so far as I have seen of th Council they have done their best. I have always advocated limited printing of papers, but I have been in a minority. A present we are in a little difficulty. Our country Members prefe our meetings being held on Tuesdays, but that is a day on whic our town Members cannot come; and the Manchester Gentlemer cannot attend except at a great loss of time—the hour at which th meetings are held absolutely preventing some from attending a all. I have no doubt if we could fix an hour which would sui both country and town Members, we might do better. Our actin Secretary is seldom present during the meetings, from this ver cause, though he devotes much time and considerable attentio to editing our proceedings. A great deal of work is done by ou Secretaries, and any one who really knows the nature of his dutie must be aware that Mr. Forbes renders very valuable services t the Society. Again I beg leave to thank you for having electe me your President for two years, and for the assistance you hav given me in carrying out the duties of the office.

Mr. Dickinson, having taken the chair, said,—We have had th services of Mr. Binney, and we have all had satisfaction in actin with him for the last two years; and I am sure that some Gentle man will be prepared to move that the best thanks of the Society be given to him.

Mr. Aitken proposed, and Mr. R. M. Knowles seconded the proposition.

Mr. Dickinson:—We must all be ready to thank Mr. Binney for his services. At the same time it is desirable that new blood should constantly be infused, and even with respect to Presidents, it is better that change should go on. They bring fresh papers and fresh Members to the Society. However, we cannot let our old friend part from us without our best wishes, and I hope that the time may soon come when we shall again see him occupying the position of President.

Mr. Binney:—Gentlemen, I beg to thank you for the vote of thanks you have kindly passed; and all that I can say is, that any service it is in my power to offer to the Society I shall be happy to render. I don't agree with Mr. Dickinson in there being any probability of my ever being President again. It is a long time to look forward to; but as far as I can be of any service to the Society I shall be most happy to render it, and I again beg to thank you for the vote you have passed.

A vote of thanks to the Chairman terminated the business of the meeting.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 2.] VOL. VII. [Session 1867-68.

The Monthly Meeting of the Members of the Manchester Geological Society was held at the Museum, Peter Street, on Tuesday, November 26th, 1867.

G. C. GREENWELL, Esq., F.G.S., President, in the Chair.

The President opened the Meeting with the following address:

GENTLEMEN,

At the commencement of the session, I beg to present to you the following short address. I need not say how much gratification it affords me to receive from you the honour of being called to preside over the Manchester Geological Society for the ensuing year. I trust that I shall be enabled to occupy the position to your satisfaction, and that when the year shall come to a close, I may resign my charge into your hands in as worthy a condition as it has been placed in mine.

The object and scope of the Manchester Geological Society are of a two-fold character. They are not confined to the investigation and consideration of Geological phenomena alone, but they embrace the study of mining economy as well, and these, it must be admitted, form a most useful combination; the investigation and reasoning of the Geologist having the opportunity of frequently being put to the test of practice, and the practice of the Miner having the advantage of scientific help in return.

There are probably few districts in England where the Geologist and the Mining Engineer can be of more mutual service to each other than that which in Lancashire and Cheshire is covered by the New Red Sandstone. The thickness of this deposit and its nature come within the province of the Geological observer, and these being placed before the Mining Engineer, he is the better prepared to make his arrangements so as successfully to overcome the difficulties which in sinking his shafts he is likely to be exposed to. I am at present assuming that under the Red Sandstone the approximate depth to the Coal-Measures may be given us by the Geologist, and I am tolerably confident that when the preliminaries are ascertained and placed in the hands of the Mining Engineer, his experience, skill, and perseverance will be found fully equal to any emergency that may arise.

As coal mining is extended in the south-easterly direction in England, it also extends in the north-westerly direction in France; and whether it will prove to be the fact that the Coal-Measures of the two countries are in reality the continuation of each into the other, is becoming daily a question of greater probability. It was formerly the opinion that (supposing they existed at all) enormous thicknesses of upper formations would have to be passed through, say in Oxfordshire and elsewhere, before the Coal-Measures could be penetrated. I think, however, that the present facilities of travelling from place to place, and the more cosmopolitan character of observers which has arisen in consequence, contribute vastly to

bring about more extended and liberal views. An observer, who sees 600 feet of Magnesian Limestone, in the County of Durham, is no longer a believer that wherever there is Magnesian Limestone it will be at least 600 feet thick. He that sees 2000 feet of New Red Sandstone in Cheshire, does not say that 2000 feet of New Red Sandstone will be found beneath the Lias of Whitby, with anything like that confidence that he would have done before he knew that in Somersetshire there were not more than 200 feet of Red Sandstone, and little, if any, Magnesian Limestone at all. He knows now that a very few feet of what may be Trias, intervene between the Chalk and Coal-Measures of the Pas de Calais.

It is very probable that as mining enterprise marches south-east and attacks the superior formations, in the search for coal beneath, we shall become acquainted with a new class of difficulties in sinking our shafts. I allude to the great expense which, in many cases, will be incurred in sinking through the running sands of the Tertiary formations. The capital expended in the establishment of some of the collieries of the North of France has been enormous. In this country we think that the expenditure of £100,000 on a colliery is very large, but some of the colliery companies of the North of France have expended considerably more than five times as much. The subject of sinking pits through running sands is very interesting, and probably during this session we may be favoured with a paper upon it, and with this, an account of such sands would have great interest.

There has not during the past twelve months been any matter more replete with frightful interest than the very sad recurrence of awful explosions of Fire-damp collieries. Those of The Oaks, Talk-o'-th'-Hill, and Ferndale alone have occurred within the period named, and have swept away no less than probably 650 lives. The subject of the ventilation of mines is therefore one in

which we all, but more particularly the mining element among us, are most deeply concerned, and I trust the session will not pass over without some contribution to our information on the matter.

As to the Geology of the neighbourhood, much has been done by many of our Members, and by none more than by our late President, whose contributions to our *Transactions* are most valuable. This field is, however, yet far from being fully developed, and affords ample scope for much further investigation, and I have no doubt but that during this session we shall have presented to us considerable accession to our information regarding it. Nothing will probably tend more to this end than the keeping up of our system of field meetings, which, from the general attendance at them, appear to be so popular among us. And I am sure I need not say that the instruction they afford does not give the entire measure of their value—the meeting of the Members together, their free interchange of opinion and information, and the social gathering afterwards, have the very best effects, and I hope that during the next year we may have several field-days together.

It seems that from the steps taken by the Natural History Society, something will have to be done by this Society without delay as to the obtaining of the convenience necessary for its Meetings and for the preservation of its Museum, and this will require our careful deliberation.

In conclusion, I sincerely hope that we shall have contributions on both geological and mining subjects; it shall be my endeavour to occupy the chair in which you have done me the honour to place me, with strict impartiality; and I trust that with a sufficient number of papers, and a full, free, and fair discussion, the session 1867-1868 of the Manchester Geological Society will not rank as the least instructive or satisfactory.

NOTES ON THE EXCURSION OF THE

MANCHESTER GEOLOGICAL SOCIETY,

TO CLITHEROE AND PENDLE HILL;

By John Aitken, Esq.

The third excursion of the Members and Friends of this Society took place on the 18th of July last. The district selected for examination being the highly instructive one lying between the vale of Clitheroe and the village of Nelson, near Burnley. The principal portion of the intervening space being occupied by the huge mass of Pendle Hill, which forms the most prominent feature in this part of Lancashire, and the two minor parallel ridges which succeed it on its eastern side—the two latter representing respectively the position of the higher and lower members of the Millstone Grit.

This district is especially interesting to Geologists from furnishing in one unbroken series a greater development of carboniferous sedimentary strata, than is to be found at any other spot in Lancashire, or probably in the United Kingdom. The aggregate thickness of which—as given by the Geological Survey,* from the top of the Upper Scar Limestone to the Arley Mine, at the base of the Middle Coal-Measures—reaches the startling thickness of upwards of 12,700 feet, to which must be added about 1,200 feet of

* Paper read by Edward Hull, Esq., B.A., F.R.S., at the Meeting of the British Association, at Dundee, in 1867, "On the Thickness of the Carboniferous Rocks of the Pendle range of Hills, Lancashire; as illustrating the author's views on the south-easterly attenuation of the Carboniferous sedimentary Strata at the North of England."—To Messrs. Hull and Tiddeman, of the Geological Survey, who joined the excursion, I am indebted for many valuable hints.

the upper members of the Carboniferous Limestone, giving a total thickness of strata, passed over during the day, of about 13,900 feet, which may be divided as follows:

Lower Coal-Measures	2,200
Millstone Grit...	5,500
Yoredale Series...	5,025
Part of Carboniferous Limestone	1,200
	13,925

If to this be added the Middle Coal-Measures, part of which are found in the Burnley district, and the Upper Measures, (which are not represented there) as found at Ardwick, we shall get the enormous vertical depth of Carboniferous sedimentary strata of 18,985, as follows:

Upper Coal-Measures, Ardwick, (none at Burnley) ...	2,013
Middle ,, (part at Burnley)	4,247
Lower ,, (Burnley)	2,200
Millstone Grit	5,500
Yoredale Rocks	5,025
	18,985

The party, to the number of twenty-three, assembled at Chatburn, and proceeded to inspect the extensive Limestone Quarries, in close proximity to the Railway Station, belonging to Dickson Robinson, Esq. On a portion of rock from whence the superficial covering had been recently removed, Mr. Tiddeman pointed out a good example of glacial markings; the rock presented a smoothed surface, and was crossed by numerous striations and grooves in the direction of north-north-west and south-south-east. Several characteristic fossils were secured, particularly a species of coral the *Syringopora ramulosa*, which is found here in great abundance in the black shale.

From Chatburn the party proceeded over the higher members of the Carboniferous Limestone in the direction of Pendle Hill, passing the village of Worston, where the Scar Limestone plunges under the Yoredale Shales at a quick angle. These shales are exposed in the brook a short distance north of the village, and contain fossils in moderate abundance; from this point to Little Merely Hall the underlying shales are concealed by a covering of drift; they are, however, again exposed in the bed of the stream behind the house, and by following the brook to its source on Pendle Hill, a clear and uninterrupted section is exhibited of the several beds of Yoredale rocks as they succeed each other, in the following ascending order:—

1—Brown and Black Shales, with bands of cherty, impure Limestone and Cement Stone.

2—Limestone—Brown, arenaceous Limestone of considerable thickness; no fossils were found, but are said to exist there. It contains numerous vesicles of various sizes, incrusted with beautiful crystals of spar. This Limestone is very variable in thickness and quality, at the northern end of Pendle Hill it becomes much thinner and is very fossiliferous.

3—Shales—Black Shales, with beds of Limestone, one of which near the bottom, is of a black colour and about 12 feet in thickness.

4—Fine Brown Grit Rock.

5—Black Shales.

6—Fine Brown Grit Rock, slightly calcareous.

7—Black Laminated Shale, with a thin band of fine brown, arenaceous Grit, and one or two thin seams of cherty Limestone near the base. This Grit is remarkable in being the highest Carboniferous rock, so far as I know, in which Encrinites occur. Some of these Shales are full of *Posidonia* and other fossils.

8—Fine Brown, Flaggy Grit; this rock attains a very considerable thickness, and forms the capping over the whole area of Pendle Hill.

The whole of the shales in this section yield fossils, several of which were collected.

Near the tip of Merely Clough, and resting upon the exposed surface of the summit rock of Pendle Hill, a number of large massive sub-angular blocks of coarse pebbly rock, of true Millstone character, were observed; and in Ogden Brook, at about the same elevation, Boulders of Gannister rock, full of the rootlets of *Stigmaria ficoides*, were also noticed. It would therefore appear, from the presence of these blocks at so great an altitude, either that the Coal-Measures formerly spread over the whole of this part of Lancashire at a period anterior to the elevation of the Pendle range and the subsequent denudation which took place, or, that they were brought into their present position by the action of ice during the glacial period.

The dip, from Chatburn to the base of the rock marked number 8 in the above section, maintains a considerable degree of regularity, ranging from 30° to 35° to the east; on nearing the top of the hill, however, it suddenly diminishes, and is found not to exceed 10° or 12° at the summit. On the eastern slope it again rapidly increases, as Padiham Heights are approached, where the strata are seen to descend at an angle of from 40° to 45°, and even in some instances reach 60° or 70°. In descending from Pendle Hill, the rock which surmounts it, (and which has been named the Higher Yoredale Grit, by the Geological Survey,) was again passed over in Ogden Clough. Near Newchurch, in Pendle, a bed of massive, coarse grit-rock occurs, from whence good building stone is obtained at several quarries. This has been named the Fourth or Kinder Scout Grit, and is classed as the base of the true Millstone Grit series, by the Geological Survey.

From Newchurch the excursionists passed on to Roughlee, where a bed of black laminated shale—overlying the last-named grit and separating it from the next in ascending order—was encountered

in the river. In it are found embedded numerous concretionary nodules, containing about eight or nine species of *Goniatites*. Two of *Orthoceratites*, one of *Posidonia*, two of *Aviculo-pecten*, and other fossils. The shales are also very highly charged with remains of a similiar character. On the ridge forming the easterly boundary of the valley at Roughlee, another bed of coarse grit occurs similar in character to the Newchurch Grit. This rock represents the Higher Millstone Grit and the Third Grit of the Geological Survey. The outcrop of the Newchurch and Roughlee Grits gives rise to two parallel ridges, which stretch across the country in well-marked lines for many miles in the direction of east-north-east and west-south-west. From this point to the village of Nelson the country is covered by drift, and no good section is exposed in the locality of the underlying series of rocks in which the Brooksbottom coals are found, nor of the overlying Lower Coal-Measures. At Nelson the base of the Middle Coal-Measures is reached, and near the village the Arley Mine is now worked. The district passed over therefore, embraces a portion of the Carboniferous Limestone, the whole of the Yoredale Rocks, the Millstone Grit series, the Brooksbottom and Lower Coal-Measures, terminating at the base of the Middle-Measures, and giving an aggregate thickness of about 12,900 feet as previously stated.

20

ON SOME INSTANCES OF THE

SUPERFICIAL CURVATURE OF INCLINED STRATA

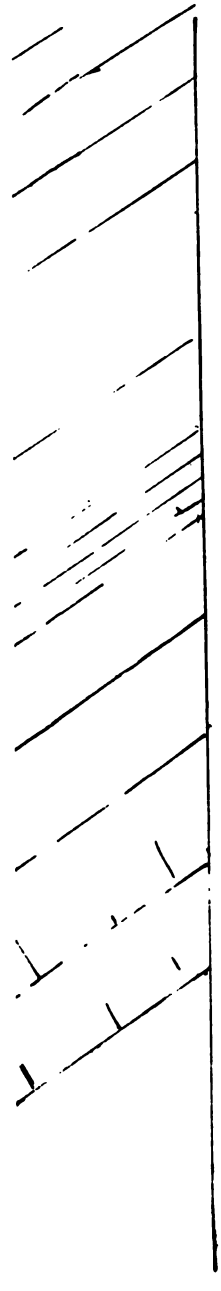
NEAR BLACKBURN;

By Mr. James Eccles, F.G.S.

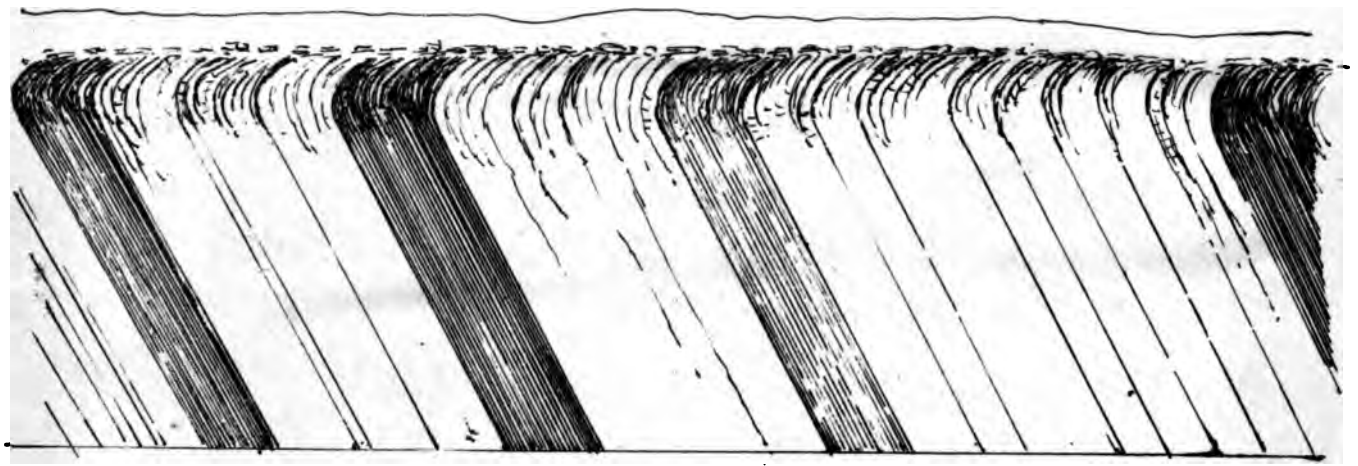
In the last number of the Quarterly Journal of the Geological Society of London, there is a paper by Mr. D. Mackintosh, F.G.S., "On some instances of the Terminal Curvature of Slaty *Laminæ* in West Somerset." It appears that the Devonian (or carboniferous) slates in the district referred to, having a general southerly dip and being of a somewhat flexible nature, exhibit in many cases a curvature of their edges in a southerly direction over considerable areas, from which it would appear that they have been acted on by some force proceeding from the north. These curved edges are usually covered by a red loamy deposit, containing many fragments of quartz. Mr. Mackintosh states that all the curvatures which have come under his notice occur either on level ground or (in some few instances) rising up a slight acclivity, and he seems to favour the theory of their having been caused by the agency of ice.

I have for some time past been puzzled to account for similar appearances in the Lower Coal-Measures and Millstone Grits in the Blackburn district. These strata to the north of the town, and for a considerable distance east and west, have an almost uniform dip to the south-south-east, at angles varying from 30° to 50°; and the curved edges, which occur frequently enough, are invariably curved in the direction of the dip of the strata. These curvatures are not found continuous over any considerable area, and in some striking instances I have found them covered with Boulder clay. In one remarkable instance indeed (fig. 1) the Boulder clay would almost seem to have been the curving agent, having apparently been forced between two beds of Sandstone, the upper one of which—when we take into account the tough, hard nature of the

Fig. 1.

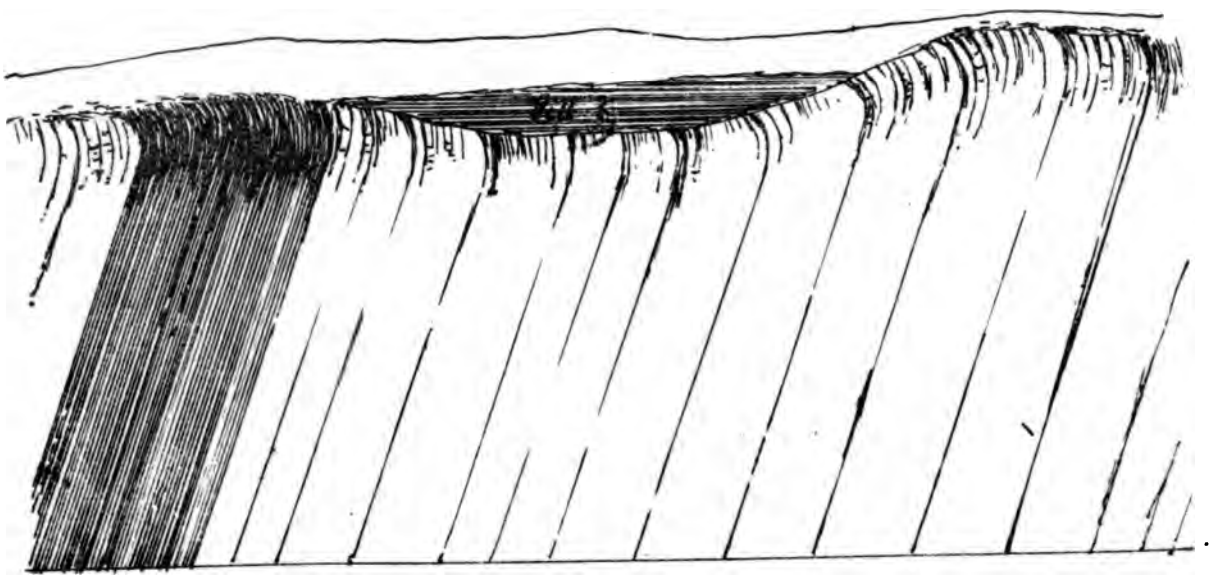


NNW SSE



SSE

NNW



rock (which is the equivalent of the Woodhead Hill rock)—has undergone a very extraordinary flexure.

The beds, as will be seen from the figure, quickly recover their normal arrangement; but proceeding a few feet further along the dip we find another curvature in an old filled-up quarry, but little of which (four feet in vertical height) is exposed, (see fig. 2.) In this latter instance the curved portions of the beds is very raggy and shattered; while in the former case, the rock is unbroken even where the Till rests upon the bent edges.

Both of these instances occur on the southern declivity of the ridge formed by the Rough Rock. In another instance,—of which fig. 3 is a representation—about half a mile distant along the strike, the relative position to this ridge is somewhat similar, with this difference, that behind the curvatures the ground is almost level for 200 to 300 yards. The curved edges in this case are in very much the same condition as those figured in No. 2.

In the neighbourhood of Little Harwood I have also met with some very interesting cases of these curvatures, of which figs. 4 and 5 are two representations. The one represented in fig. 4 occurs on almost level ground, and near the top of a ridge. There is no covering of Till but only from two to three feet of earth, at the bottom of which is a layer of fragments of sandstone and shale horizontally arranged on the edges of the strata; this may be owing simply to atmospheric disintegration. In the depression shewn in the middle of fig. 5, there is a patch of what I took to be Till, but from its position I could not verify this. In both these latter instances, I doubt not, that the regularity of the curvatures is owing to the thin bedded, laminated character of the rock, and to the frequent intercalation of beds of shales.

Through the kindness of Mr. Tiddeman, of the Geological Survey, I have had an opportunity of seeing two of the curvatures

in the Yoredale Shales, near Twiston. One of them is found in the stream a little more than a quarter of a mile south of Twiston Mill, and the other at a corner of road at a place called Clough-Head. Both are similar to those which I have already described, but the direction of the curvature is *up-hill*. I do not know any other instances in the Limestone district.

It seems to me a matter of some difficulty to arrive at a satisfactory explanation of these phenomena. The instances which first came under my notice, being on the southern declivities of the hills, impressed me with the idea that they might be attributed to the gradual working downwards of the overlying Till or earth, and the broken and ragged appearance of some of them at first confirmed this impression. I could not, however, entertain this opinion after finding instances on level or on rising ground, where the above-mentioned cause could not be supposed.

The theory that these curvatures have been produced by the agency of ice in some form, seems to me the most plausible. It will, however, be rather difficult to say what form the ice assumed; for if we suppose a sheet of land-ice moving southwards, it will be necessary to suppose a subsequent submergence and upheaval to account for the presence of the overlying Boulder clay; and it is questionable whether, during the period of submergence, the curved edges, so shattered and broken in many cases, could have escaped denudation. It would hardly be possible that they should be the work of icebergs, for many of the curvatures occur from 100 to 200 feet below the top of the ridge, and on the south or lee side. Again, the drift-ice theory seems open to both the above-named objections. I cannot, however, consider them as absolutely conclusive, as I cannot imagine what other agency could have produced the same effect. In connexion with the above, I may state that I have found a very fair instance of glacial striation at Mellor, near Blackburn, and Mr. Tiddeman has also pointed out to me a very good '*roche moutonnée*,' near Whalley. The *striæ* in this latter case run north-north-west and south-south-east.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 3.] VOL. VII. [Session 1867-68.

The Monthly Meeting of the Members of the Manchester Geological Society was held at the Museum, Peter Street, on Tuesday, December 17th, 1867.

G. C. GREENWELL, Esq., F.G.S., President, in the Chair.

The following paper was read:—

ON A PORTION OF THE

CENTRAL INDIAN COAL-FIELD;

BY ARTHUR SOPWITH.

A brief description of any distant coal field must necessarily be devoid of a great deal of interest to the geologist who requires accurate detail to enable him to infer the relation which such series may bear to the well explored European ones, but I have thought that a general outline of the nature of the strata composing the central Indian measures may at least possess some little interest to those who are unacquainted with the geology of India.

From the characteristic nature of coal-bearing strata, as well as their commercial value, they form, where well developed, the best standard on which to base the geology of a country, and though to collect evidence by which to classify them, must be the work of time and very careful examination, there is not much reason to doubt that, shortly, sufficient data may be gathered respecting the vast coal fields of Asia, to refer, satisfactorily, their age to those of Europe and America: a classification which must possess the greatest interest to the geologist.

With regard to such question, however, the following remarks can possess but little interest, as they are merely a rough summary of the geology of a comparatively limited tract of country, and my principal object in writing them is to impart at least a slight interest to some specimens of coal, &c., which I have collected from those measures, and further, with the hope that the subject being brought before the Society, it may give rise to some remarks from those members who may be acquainted with it.

A belt of coal measures extends more or less interruptedly from near Calcutta, in a westerly direction, more than half way across the Peninsula, and it is on the western extremity that I intend making a few remarks.

The portion referred to extends from a point which may be taken as the most central station in India, towards the west for a distance of about 140 miles; varying greatly in width, the widest part being nearly 60 miles; the area embraced containing, at a rough estimate, about 500 square miles.

The northern boundary of the measures throughout the length is along the south side of the plain of the Nerbudda, and is well defined by a range of hills which rises abruptly from the plain, and which preserves a very straight course. Geologically, these hills are not a boundary, but it is only within them—that is, the south of them—

that the coal-bearing strata are found, the low ground of the plain being occupied by metamorphic rocks. To the south the coal measures are also limited by the crystalline rocks against which they are apparently faulted.

The hills throughout the included area consist principally of massive sandstones, forming a series classed by the geological survey as the Mahadewa—taking their name from the principal hills in the district. These overlie the coal measures, and in the valleys and ravines the latter are exposed; and, although it is difficult to form correct views as to the relation which various sections bear to one another, there are throughout certain areas, sufficient characteristics of strata and coal seams to warrant the subdivision of the coal-bearing series into groups.

By the geological survey they have been divided into two series, upper and lower; but I think there is a sufficient difference in the nature of the strata and thickness of carbonaceous deposits to warrant their division into three groups, at any rate for the purpose of a general description.

The first or upper of these occupies the ground to the east.

The second occupies the middle area of the tract and is well exposed at both north and south boundaries, at a distance of 60 miles apart.

The third, occupying the largest area, extends from the last mentioned to the western boundary, where it is covered by trap, which, in some localities, immediately overlies the coal-measures. The country is, in all directions, traversed by trap dykes, only some of which cut through the overlying sandstones.

Underlying the coal-measures exist some strata, consisting characteristically of green sandstones, shales, and earths; but it is

very questionable whether they represent a distinct formation to the lower coal-measures.

The general physical and geological features of the tract mentioned then are, coal-measures with a set of green beds at the base, overlaid by sandstones, which again have been covered by overflowing trap, the denudation caused by the water courses exposing the measures in various localities throughout the area.

Upper Measures.

These consist of thick beds of sandstone, and thin beds of shale and coal. The latter generally having a sandstone cover, are very irregular. The sandstone beds are for the most part of a soft nature, and sometimes earthy.

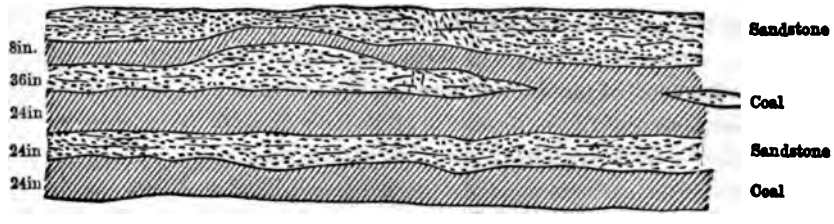
The following is the most complete section I saw of these rocks:—

		Ft.	In.
(1)	Massive sandstone		
(2)	Dirty shale, with threads of coal running parallel to lay of beds	1	4
(3)	Yellow sandstone	1	8
(4)	Shaley sandstone, with coal pipes, lying vertically to lay of beds	2	6
(5)	Compact sandstone, containing balls of iron pyrites and small pieces of bright coal... ...	2	0
(6)	Light blue shale, with traces of coal	1	1
(7)	Hard yellow sandstone, with balls of iron pyrites	0	8
(8)	Dark blue shale, with traces of jetty coal, a small band of coal, 7 or 8 in. thick, near the top, but very irregular. This coal varies much in quality, and is replaced within a short distance by shale, which in some parts is micaceous	1	2
(9)	Sandstone	10	2
(10)	Blue shale	7	0
(11)	Sandstone	20	0
(12)	Blue shale, with a band of hæmatite, varying from 4 to 8 inches.	3	0

(13)	Sandstone	2	0
(14)	Shale, with traces of coal	10	0
(15)	Sandstone		

Within a distance of 9 or 10 miles from where this section was taken, I had an opportunity of examining several sections where coal is exposed. In nearly every instance the roof consisted of thick sandstone, and with only one exception, did I see any floor resembling fire clay.

The most important seam in the locality is one of very irregular section and embedded in sandstone, of which the following is a sketch :—



The beds of coal are very much mixed with shale, but there are some thin veins of bright coal. The sandstone in many places is quite black from the admixture of carbonaceous matter. In the same neighbourhood also there is a bed of very carbonaceous sandstone, without any trace of pure coal. The following is another curious section taken from this group :—

	FT.	IN.
Massive sandstone		
Blue clay	2	3
Dirty coal	0	6
Blue clay	4	0
Micaceous shale	1	0
Sandstone		

In the clays forming roof and floor of seam are interspersed little clumps, and most irregular threads and veins of coal inclosing in section pieces of the clay.

Some specimens of coal from these upper measures are very light and bituminous, though generally very dirty. The frequent occurrence of nuts of coal and coal pipes in the shale and sandstone, and the admixture of these latter with the beds of coal, lead to the conclusion that during the formation of these measures there were no regular or thick deposits of coal, but only a comparatively irregular admixture of carbonaceous matter, the debris of that which formed the thicker and richer beds below.

Middle Group.

The distinction between this series and the one just described, is decided by the difference of fossils, a slight difference in the nature of the strata, and further, by its containing much thicker coal deposits.

It consists of more compact sandstones and shales than the upper series. The following is a section of part of the series.

Conglomerate of Mahadewa overlying unconformably the coal-measures.

Yellow sandstone	40 ft.
Coal	13 „
Yellow and irregularly laminated sandstone ...	30 „
Coal	14 „
Light blue shale	20 „
Fine grained buff sandstone	36 „
Beds of very finely laminated sandstone, red and white	20 „
Coal	12 „
Finely laminated sandstone, very thin beds of shale, sandstone, coal, and red ochry earth	70 „

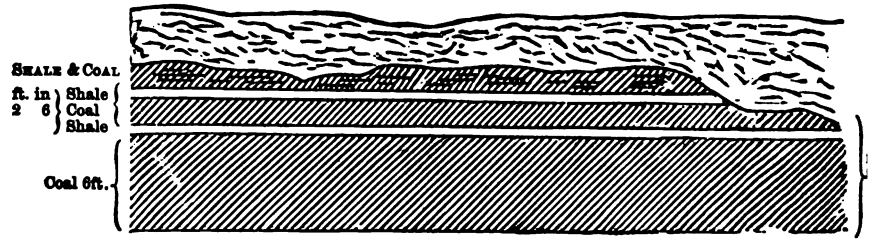
At a distance of about 60 miles south from the point where the above section was taken, coal-measures are again exposed, and there appears sufficient analogy between the strata and characters of the seams to class them as belonging to the same series. The country between these points, is occupied, as I have already mentioned, by hills of sandstone, and the country generally is covered by trap, which, in the case of the following section overlies apparently the coal-measures.

Coarse brown sandstone	6 ft.
Light blue shale	1 „
Bituminous shale	3 „
Sandstone	1 „
Light blue shale	2 „
Sandstone	2½ „
Light blue shale	4½ „
Coal	13 „

The trap appears to overlie the beds to the north, and from the fact of there being trap on each side of the river where the measures are exposed, it is very probable that they were at one time entirely covered by overflowing trap.

A trap dyke is seen to cut through the seam of coal mentioned in section, which, however, is very little disturbed or altered in quality by the contact. (The largest piece of coal amongst the specimens is taken from within a few feet of the dyke.)

Only one of the numerous seams to the south of the coal country is worked, and that to a very trivial extent. It is quarried, and the section in the face shows very distinctly the denudation to which the seam has been exposed, the cover for some distance being merely soft clay.



The middle series to the south occupies a table land, but on passing to the west a watershed is reached, and a very steep descent leads down to the valley of one of the tributaries of the Nerbudda. Near the edge of the high ground are found greenish shales, and on descending below are found the characteristic green beds of the Talchir group, some of which here contain granitic pebbles.

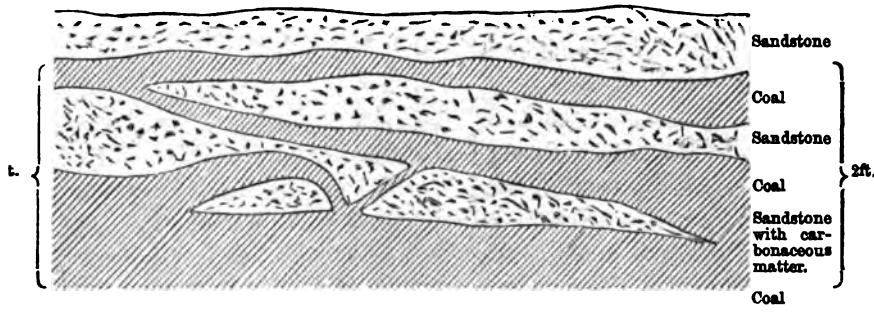
A very short distance further west, however, coal is again exposed, the beds with which it is associated being very distinct from those of the higher series.

Lower Measures.

The principal characteristics of this, the lowest series, are green and grey shales, and laminated sandstones, with beds of coarse

gritty sandstone. Some of the sections are extremely rich in coal deposits, though the beds are thin, in few cases exceeding three feet.

The seams are generally regular when accompanied with a shale roof, but as is often the case, are very irregular when covered by sandstone. The following sketch is of a seam in this series :—



The green and grey beds and coal seams composing the lower measures are overlaid by massive sandstones; and, as in some cases I walked over a distance of seven or eight miles without coming to any section of coal seams, or their associated beds, it is natural to infer that they must be of great thickness.

As a summary of the whole series then, there is first, in descending order, a group of sandstones and shales bearing considerable resemblance to our coal-measures, the upper portion containing so far as is known, only thin seams and traces of carbonaceous matter very much scattered through their accompanying beds; the lower portion containing beds varying from a few inches to several feet. Between these beds and the lowest series of coal beds exists a great thickness of massive sandstone, while the lowest series itself consists principally of greenish laminated shales and sandstones, associated with a great number of thin beds of coal.

It may very easily be understood that in a district which is so little explored, and of which the geology is derived principally from isolated sections, which, in most cases, are of very limited thickness, it is a difficult matter to conjecture even the thickness of the measures.

The minimum thickness of the lowest series has been estimated by Mr. Medlicott at 700 feet, and the overlying sandstones at 450; but it is most probable that they are very much thicker. With regard to the others it is useless mentioning a supposed thickness, which may be so far wide of truth.

The specimens of coal on the table will give a better idea of the nature of the coals than any description. They are all very bituminous, and the only difference between the specimens from the different series appears to be that those of the highest series are lighter and more bituminous. There is no very distinct difference in the nature of these coals from those of the lower groups, the quality depending more upon the proportionate admixture of shale. Some of the bright and pure specimens have a conchoidal fracture, the very dirty ones an irregular one, while in those in which there is a more intimate mixture of shale, the fracture is cubical.

The cleavage I noticed in several instances to be S. 70 E.

An average analysis of seven samples from the middle group gives:—

Fixed Carbon.	Volatile Matter.	Ash.
54·63	26·21	19·16

I may here observe that in only one district in India, viz., the Kurhurbari coal field, are found coals approaching in quality to those of England. An analysis of three of the Kurhurbari coals giving—

Fixed Carbon.	Volatile Matter.	Ash.
68·8	23·9	7·2

In the upper series, according to the Geological Survey reports, are found *Taxodites*, *Cupressites*, *Widdringtonites*, and *Lycopodiaciæ*; but, in the lower ones, there is an entirely different fossil flora, of which the following is a list given by Professor Oldham, in the Geological Survey report of India:—

Sphenophyllum.
Vertebraria.
Phyllotheca.
Cyclopteris.
Pecopteris.
Glossopteris.
Calamites.
Schizoneura.
Zamia. (?)

Vertebraria has only been found in India and Australia, where it is remarkably abundant. It has been referred to the genus Sphenophyllum, but Professor Oldham considers it to be a root with rootlets attached, and that they contributed largely to the formation of coal in India, playing the same part as *Stigmariæ* do in our English fields.

It will be observed that neither *Sigillariæ* nor *Lepidodendra* are found.

The same authority sums up the evidence of the fossil flora. "The probability, therefore, would seem to be that our Damuda "system (by Damuda is meant the two lower groups, the highest "one being distinguished as Upper Damuda,) belongs to some "portion of the upper palæozoic division of European geological "sequence, or to the lowermost portion of the mesozoic division. "In fact we may hereafter find that it represents that great interval "indicated by the marked separation and break between the two "series in other countries."

But it is improbable that a complete analogy can be drawn out between the flora of geological divisions so far removed, and therefore a knowledge of the rock equivalent should be combined with such evidence.

The conclusion as to the age of the 'Damuda' rocks quoted above, is arrived at by a comparison with the Australian measures. There, the coal-bearing strata are covered by rocks, which, from their containing mineral salt, and also from fossil evidence—slight, it is true—may be referred to the new red sandstone. Below them are sandstones containing a comparative abundance of carboniferous limestone fossils, and the gradation between these and the coal-bearing strata is, according to some authorities, such as to lead to the conclusion that there was no very great interval between the formation of them and the coal series. Further, the coal-measures appear to contain many fossils prevalent during the carboniferous epoch.

There being several species of flora common to the Australian and Indian coal-fields, it is reasoned that the Indian measures are older than would appear from a mere comparison of their flora with those of European formations.

In conclusion, I may remark that I had at first merely the intention of bringing a few specimens of coal for examination, but I thought that also a few remarks, however brief, would not be out of place, and I have confined them as nearly as possible to what I considered necessary for a mere sketch, hoping, however, to have shortly an opportunity of examining in detail at least a portion of the lower measures, and of preparing a more detailed paper on the subject.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 4. VOL. VII. [Session 1867-68.

The Monthly Meeting of the Members of the Manchester Geological Society, was held in the Museum, Peter Street, on Tuesday, January 28th, 1868.

G. C. GREENWELL, Esq., F.G.S., President, in the Chair.

The following Gentlemen were elected Ordinary Members of the Society:—Mr. James Brocklehurst, High Lane, Stockport; Mr. G. Kearsley, Vale View, Bowdon; Mr. Thomas Fletcher, Haulgh, Bolton.

It was unanimously agreed that the best thanks of the meeting should be conveyed by the Secretaries to B. Chaffer, Esq., of Nelson, for his kindness and courtesy to the Members of the Society, on the occasion of the visit to Pendle and that neighbourhood.

The following paper was read—

ON THE EXCURSION TO HOLCOMBE, &c.;

By Mr. James Eccles, F.G.S.

On Saturday, the 26th of October last, an excursion to the neighbourhood of Summerseat and Holcombe was made by a number of the Members of the Manchester Geological Society, and their friends.

The party, having assembled at the Summerseat Station, immediately proceeded under the guidance of Mr. Aitken to inspect the fault which is seen in close proximity to the station. Mr. Aitken explained that this fault, striking north-north-west and south-south-east, has a south-west downthrow of 300 yards or upwards, bringing down the Arley Mine to the level of the higher beds of the Millstone Grit.

We then proceeded to the fine section exposed in the Irwell, above Mr. Robinson Kay's Mill, where a seam of coal with a sandstone roof is seen, and below it a great thickness of shales, which in the steep cliff on the south bank of the river, yield very fair specimens of plant remains.

Retracing our steps, we next turned our attention to the Holcombe Brook section. After passing over a considerable thickness of grits, exposed in the lower part of Holcombe Brook, (the upper members of the Millstone Grit series according to the Lancashire geologists, or the lower members of the Geological Survey) the lowest of the Holcombe coals was reached. This seam, which is about fifteen inches thick, has a sandstone roof, and in the underclay plants are found together with *spirorbis carbonarius*. It is probable that this is the same coal as the one previously seen in the river section near Summerseat. The presence, however, of such a thickness of shales under the coal in the latter section, and their absence in the Holcombe Brook section, is worthy of notice.

Proceeding up the stream above Holcombe, shales and two thin coals were passed over; and in the shale above the higher coal, *aviculo-pecten*, *posidonia*, and *goniatites* were found in abundance.

Ascending the southern slope of Holcombe Hill, we passed over a great thickness of shales containing a subordinate course of flag-rock, and afterwards over the Haslingden flags and Rough-rock to the summit. Here our attention was directed to a thin bed of drift gravel, which is exposed within twenty or thirty yards from Peel's Monument. Pebbles of granite, syenitic granite, porphyry, and fine silurian grit were found, the two latter in comparative abundance, and one stranger, apparently a true flint pebble, was secured by Mr. Aitken. This is remarkable as being the highest drift deposit observed in this district: the height of Holcombe Hill being 1162 feet above the sea-level.

The extensive quarries on the east face of the hill were next the objects of examination. Here the Rough-rock is well seen both above and below the Featheredge coal. The Haslingden flags are also exposed in the same quarry, separated from the Rough-rock by the unusually thin parting of one foot of shale.

Proceeding thence northward along the Moor above the old road, we visited another quarry in the Rough-rock above the Feather-edge coal, from which excellent building stone is obtained. Some of the beds here were extremely suggestive of their granitic origin, and had almost the appearance of recomposed granite.

Continuing in the same direction, at about the same level, we arrived at a quarry in which a hard brown silicious rock is worked for road material. This rock, which has been considered to be the highest bed of the Millstone Grit series, owes its position in this locality to a fault running north-west and south-east, bringing down the Rough-rock on the south side to the same level. This would give a downthrow not far short of 200 yards.

A thin seam of coal was observed under this silicious rock, and above it were very dark shales containing *goniatites*. After some time spent in searching these shales, we commenced to descend into the valley, following the course of a stream from this point, in the higher part of which a considerable thickness of shales is exposed. Further down the stream, in Paradise Clough, the thick beds of the Millstone Grits were passed over. We then went by train from Ewood Bridge to Rawtenstall, where we were most hospitably entertained at dinner by Richard H. Hardman, Esq.

Mr. Plant:—I am afraid the reference in the paper to the granitic appearance of a grit we saw in one of the quarries may lead to misconception. On close examination we shall find no affinity between any granite and the specimens of grit alluded to by Mr. Eccles.

Mr. Eccles:—The paper merely states that the grit is suggestive of its granitic origin, and has the appearance of *recomposed* granite.

Mr. Binney:—I can to some extent bear out what Mr. Eccles has said. I have often had the idea of taking pieces of flag-rock with scales of mica and pieces of rough-rock, with feldspar and quartz in it, and submitting them to the process which Watt adopted, and I think I should produce something very like what he did. You might not by that means get standard granite, because it is very difficult to say what standard granite is, but you would probably get something like granite.

Mr. Aitken:—In the bed of gravel referred to as occurring on Holcombe Hill at a considerable elevation, I have found various kinds of rock pebbles, a few of which I intended to have exhibited here to day, and also to have offered a few remarks upon the bed of drift in question, but from indisposition I have been unable to

complete the paper I had sketched out: perhaps I may, if desirable, refer to the matter at the next meeting. I should have been glad if Mr. Binney had said a few words on one point referred to in Mr. Eccles's paper. In the section at Summerseat a thin bed of sand-rock underlies the lowest bed of coal, and succeeding that, is a very thick stratum of shales: but underlying what are apparently the same rocks, at Holcombe Brook, there are only a *thin* bed of shale and a very thick bed of sandstone. The two sections are not far removed from each other, and I should like to hear if Mr. Binney can account for so remarkable a change of strata in so short a distance?

Mr. Binney:—The occurrence is remarkable, and difficult to account for. We know, however, that strata thin out remarkably fast in certain places, and probably this is an instance of the kind. My friend Mr. Hall first shewed me these coals. He knew them sixty years since. He had observed three beds, and I have seen them in Yorkshire and other parts of England, and they seem to be very persistent. Professor Phillips did not notice them in his "Geology of Yorkshire." All I can say is, that we have never seen any other than these three beds of coal, but there may, notwithstanding, be another bed. I should be glad if Mr. Eccles would examine the coal at Sunnyside and other places. There is another point to which I think we are entitled to call attention: and that is, Mr. Aitken finding pebbles in the drift on the top of Holcombe Hill. I have never seen them on that spot, but I have seen them not far below, near the quarry spoken of, and I was surprised at the great height at which they were found. Any one standing on the top of the hill, and looking at the surrounding country and the valleys below, will there see something of what atmospheric and aqueous causes may have done long before the drift came there. And when you look down and see the till in those valleys and on their sides, you will be strongly in favour of the views of the new school of geologists, which insists that, however

we may now find marine deposits in them, they were chiefly the result of long ages of sub-aerial erosion. I trust Mr. Aitken will bring the matter more prominently before the Society.

Mr. Plant:—I would call the attention of the Members of the Society, and particularly of mining gentlemen present, to this candle which was found in 1863, in a Flintshire coal-mine when the mine was drained. It had been under water for eighty years. The tallow has been turned into a hard soap (*Adipocere*,) and is coated with oxide of iron. The wick lights, and will consume readily.

ON THE

GLACIAL GROOVINGS ON THE BUNTER SANDSTONE,

AT ORDSALL CLOUGH, SALFORD;

By Mr. John Plant, F.G.S., F.A.S.L.

(Plates V. and VI.)

At the meeting of the Society in May, 1867, I drew the attention of the Members to the immediate discovery of numerous deep glacial groovings upon the surface of the Pebble beds, which had become exposed by the removal of a great depth of Boulder clay in the course of forming an extension of Oldfield Road, across the fields so well known to local archæologists, as Ordsall Clough. As more than ordinary interest was attached to the present discovery, from the fact of its being locally quite unique, there not appearing, as far as my knowledge extends, any preceding record of the preservation of the marks of glacial action on the rock surfaces in the locality of Manchester, I have taken considerable care, in making my observations on the spot, to record all the details

connected with the groovings; but they have been, for the greater part, a mere record of facts, from the favourable circumstances under which the groovings were displayed.

The picturesque features of the neighbourhood of Ordsall Clough and the lane leading to Ordsall Hall were familiar enough some years ago to the local naturalist and the lover of romance, who often sought its shady banks and the moss-lined cavern in the rocks, dignified by the traditional name of *Woden's Den*, but in the present day, the devastating spade of the brickmaker, and the necessities of municipal improvements have utterly destroyed the fine group of trees, and swept away for ever all that was once romantic about the Clough, which is being now converted into a useful plot of streets and cottages.

My attention was first directed to the excavations at Ordsall Clough, by the road contractor, Mr. Thomas Lowe, to whom I am indebted for much information upon local geological matters. He informed me that the men had come upon a singular layer of "stone pipes" in the Red-rock, and, as he had never experienced anything of the kind before, he wished me to look at it before it was all destroyed by the carting and levelling of the road. Upon visiting the spot the same day, the true nature of the "stone pipes" was readily suggested by their resemblance to the glacial groovings I had seen on the Cambrian slates in North Wales. The excavation for the new road commences on the level with Regent Road, and gradually declines at the rate of one foot in 43 feet to the level of Ordsall Lane, where the excavation through the Boulder clay is 12 feet, and in the Red sandstone 6 feet. The excavation for the new road passes through Boulder clay, and about half way down, the surface of the sandstone comes to the level, and forms the road for a short distance; (plate V., fig. 2.) It was at this place that the "stone pipes" were lying, and although covered with mud and water, were prominent enough to be felt by walking over them. After clearing the surface, the appearance

presented to the eye was that of a number of deep cart ruts, with rounded ridges, all parallel with each other, running half across the road and disappearing quite under the bank of Boulder clay, which was 10 feet high. The exposed area was about 12 feet, measured across, and 9 feet along the groovings, and upon the surface were eleven very prominent ridges, or "stone pipes," and seven very deep groovings, with intermediate ones of smaller size. As it became necessary in a few days to break up the sandstone, and as all visual evidences would be destroyed, I therefore thought it desirable to save a part of the finest groovings, which was effected after a good deal of labour and trouble in raising a mass of about three tons of false-bedded and soft sandstone; it forms a block of about five feet square, showing some of the prominent ridges and grooves.

Altogether the men cleared the overlying clay from about 14 feet in extent, and I was enabled to make very accurate measurements of the markings on the surface; the deepest of the grooves is five inches across and three inches deep; the prominent ridges are well rounded, and of equal proportion to the grooves, (plate VI); after carefully washing the surface of the sandstone free from all clay and mud, a remarkable change was discovered; the glaciated surface of the sandstone, which is here of a harder silicious character than usual, and yellowish red in colour, was found to be black and partially polished; the gritty particles are half worn down, and exhibit the surest signs of a grinding action over the surface; this black polishing was especially seen when care was taken, after separating the Boulder clay from the sandstone, to preserve the surface from contact with extraneous dirt and water.

The Boulder clay lies directly upon the glacial groovings on the sandstone; in fact, very fine casts of them were obtained by carefully separating the clay from the sandstone; and along the line of contact seen in the section from the level of the sandstone where they were first met with, to the end of the bank at Ordsall Lane, a distance of

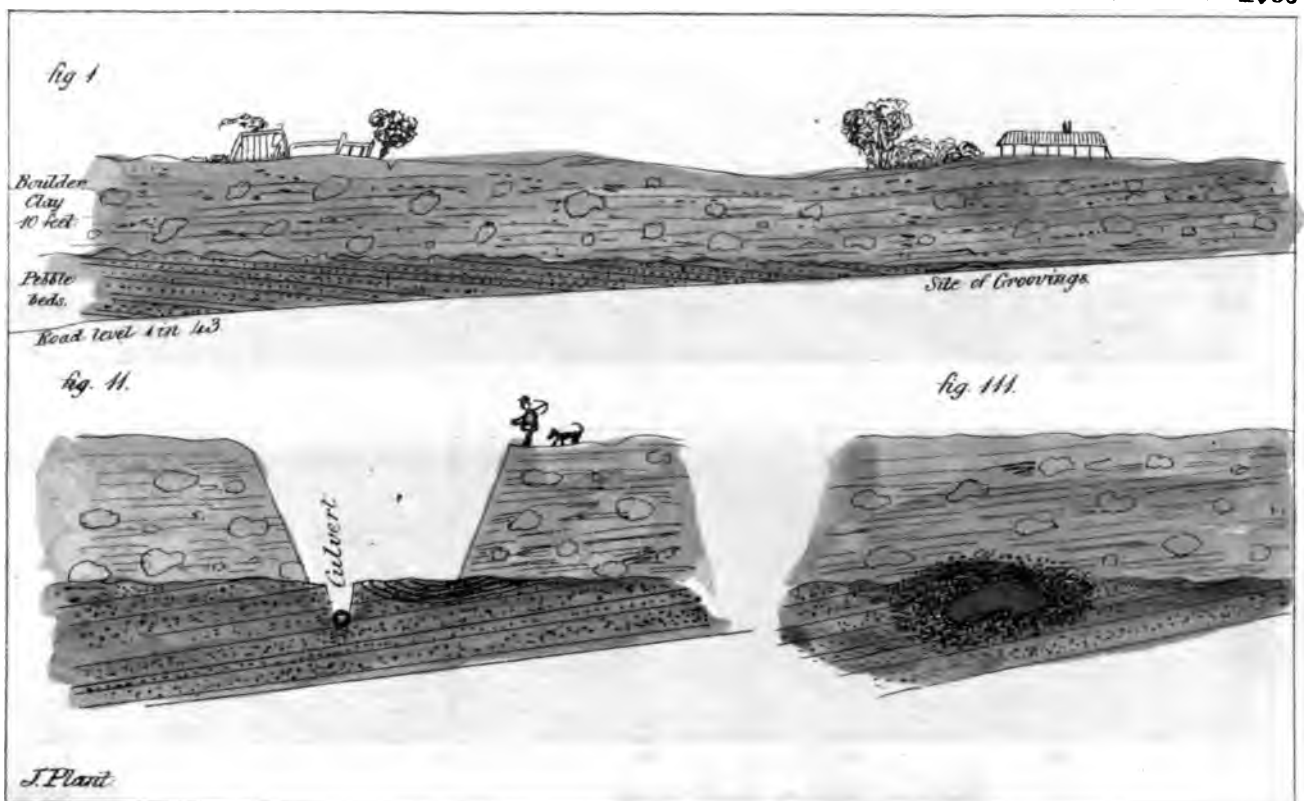
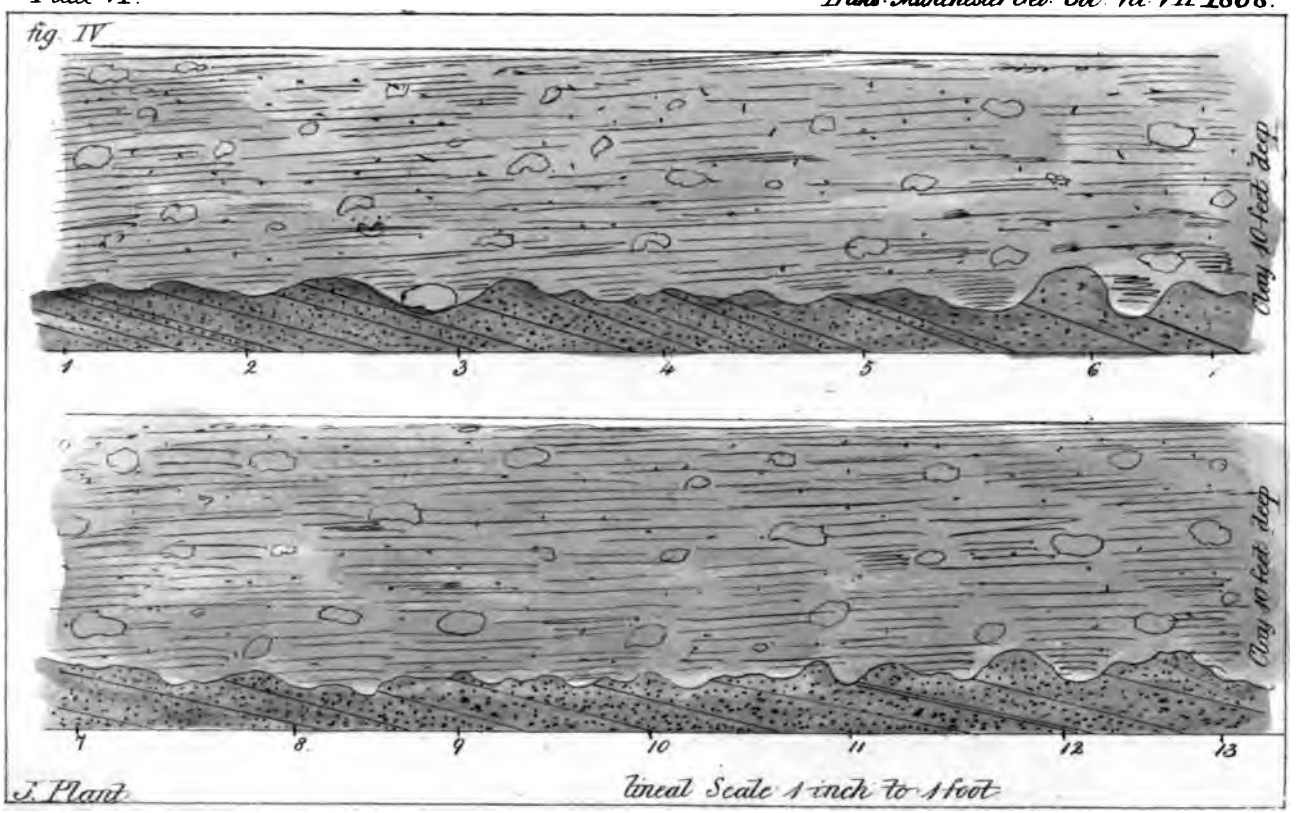


fig 1. Section 50 yards long shewing the grooved surface of the sand stone under the Clay.
fig 2. Section across the road at the exposed groovings.
fig 3. Section shewing trap boulder in the sand stone.



SECTION OF THE GLACIAL GROOVINGS ... ORRSALL CLOUGH

50 yards, the wavy outline of the grooved surface of the sandstone could be readily seen, showing that a considerable area of the surface of the sandstone, yet buried under the clay, was deeply grooved and marked by glacial action, (plate V., fig. 1.)

In this locality, the New Red sandstone is nearly everywhere covered to a considerable depth with Boulder clay, except on the alluvial flats of the river banks, and the clay is sometimes covered by gravel and sand, lying in patches, to an average depth of six feet. Over these sands, on the high ground, is an occasional bed of stiff yellow clay, twelve inches thick. The depth of the Boulder clay is very inconstant from the hollows and depressions in the sandstone below; it is rarely less than eight feet thick and increases to over 30 feet. In the new road extending to Cross Lane 26 feet of clay was sunk into without reaching the Red sandstone. At Ordsall Clough the sandstone was capped by an average thickness of 12 feet of clay, whilst the gravels and sand are wanting, perhaps removed at a later time of denudation, if they ever were deposited there.

The bench mark by the Ordnance Survey at Regent Road bridge shows the level of the river Irwell just 500 yards from the Clough to be 36 feet 6 inches above the sea level. The reservoir at the Ordsall Dye Works is 51 feet higher, viz., 87ft. 6in.; the exposed surface of the sandstone rocks upon which the glacial groovings are seen at Ordsall Clough, is 96 feet, and the bench mark at the Infantry Barracks, 400 yards from the river, is 112 feet 7 inches above the level of the sea; the clay near the Barracks is above 20 feet thick, and the floor of New Red sandstone under the clay is therefore nearly level for more than a quarter of a mile from the outcrop at Ordsall Clough. The mean height of the exposed surface of the New Red sandstone, above the sea level, is 96 feet. The beds dip to the south-west, at an angle of 15 degrees to 20 degrees, and at a depth of 460 feet in the well-bore at the Ordsall Dye Works the bottom beds were not reached; these Pebble beds extend under most of Manchester and Salford, although from the

depth of the Boulder clay it is rarely that the sandstone is seen outcropping to the surface.

Many of the Members will be familiar with the interesting account by Mr. G. H. Morton, F.G.S., of the finding of glacial markings on the New Red sandstone in the valley of the Mersey at Toxteth Park, Park Road, Kirkdale, Bidston, and other places near Liverpool; in these instances Mr. Morton does not mention any of the furrows or ridges as exceeding an inch in depth or prominence, and with this exceptional point in favour of the greater magnitude of the groovings at Ordsall Clough, the occurrences are very similar both at Liverpool and at Salford.

The direction of the groovings is of importance, as it pointed down the river valley: this direction is coincident with the striæ observed by Mr. Morton, near Liverpool, viz. :—

Ordsall Clough, Salford	N. 40° W.
Park Hill, Liverpool	N. 42° W.
Bidston, Liverpool	N. 30° W.
Kirkdale, Liverpool	N. 15° W.

The general occurrence of rolled and striated boulders of Palæozoic rocks is so well known about Manchester as a feature of the Boulder clay, that I should not allude to it had it not been for the sake of recording the appearance of two large boulders of trap which were found entirely surrounded by the sandstone of the pebble beds; they were actually imbedded at the top of the sandstone, looking as if they had been dropped from a great height, and by the force acquired in falling had been buried sufficiently deep to be below the Boulder clay, (plate V., fig. 3); in some places large stones were actually taken out of the deep groovings, which in one case it was quite apparent had been the veritable agent in scooping out the groove.

Mr. Aitken:—I have much pleasure in moving a vote of thanks to Mr. Plant for his interesting paper. On the discovery of these groovings I visited the place with Mr. Plant, and had the pleasure of seeing the surface of the sandstone before it was disturbed. I can bear testimony to the accuracy and faithfulness of the description which Mr. Plant has given. It is a strikingly interesting instance of glacial action, one of the best, I believe, yet discovered on the western side of the Pennine chain; from the nature of the sandstone rocks, and their perishable character, it is not often we find marks retained on the surface, but in this case they are very distinct, and it would be very desirable to have a record of this discovery published.

Mr. Knowles seconded the motion, which was carried unanimously.

Mr. Binney:—The specimens shown by Mr. Plant are very interesting, and are similar to those which Mr. Morton discovered in Liverpool, which I saw some years ago, but I think his were probably more sharply and deeply cut than these. Some of the grooves were several feet long, and one of the polished spaces probably between 20 and 30 yards in length. The striæ were very sharp, and they were in the direction stated by Mr. Plant. They are similar to the glacial markings on the south side of the Isle of Man, which are also in the same direction. Mr. Plant here shows the till resting directly on the pebble beds. There is no bed of gravel underneath it. Sometimes between the bottom of the till and this eroded rock you will find several yards of sand, and often about a yard or so of coarse gravel, but here appears to be nothing of the kind. The little pebble which Mr. Plant now shows has been a good deal polished; but this is exactly the same shape as a piece of limestone which I found at Ardwick, where it had been working a hole in the triassic beds, (which Mr. Hull puts down there as Permian sandstone, under my protest.) It had there made a round conical hole. This boulder which Mr.

Plant has figured is very interesting, (plate V., fig. 3). I do not know whether he examined it all round to see whether it was conical in shape. I think if attention is directed to the surface of any of the rocks in this neighbourhood when the till is removed from them we shall find a great many of these glacial markings.

Mr. Plant:—I believe the whole surface of the sandstone about Ordsall Clough would be found marked by these groovings, if the clay could be taken away; should the opportunity occur, I intend to get a finer specimen, and preserve it. I did not think it necessary to give a description of the boulders of the till at Ordsall Clough, but it may be taken that seven out of ten are limestone boulders; and amongst them are some extraordinary specimens, which deserve a detailed account; the fossils which are found in some of these boulders are very peculiar: there is a piece of fossiliferous sandstone which contains encrinites, very similar to a sandstone we found on Pendle Hill.

Mr. Binney:—There are some of these stones, which have the appearance of rotten sandstones. I fancy they have formerly been a calcareous sandstone from which the lime has been dissolved out.

Mr. Plant:—The pebble beds at Ordsall Clough are intersected by narrow fissures, and these are invariably filled up by walls of clay, infiltered from the overlying till clay, which prevent the free passage of the water in the sandstone.

Stone Weapon near Manchester.

Mr. Plant called attention to a stone weapon which had been found in the valley of the River Mersey; it was a fine axe thirteen inches long by three inches wide, and although found

in 1846, had never been noted in the records of the Society. He had investigated the manner of its occurrence, and obtained a very fair account of its wanderings from Flixton to its present resting place in the Blackmore Museum, at Salisbury. It was stated to have been found in the valley gravels at Flixton; but this statement is not quite correct.

Mr. Binney:—That is about the place where we might expect such things to be found. It would form a suitable subject for a separate communication. It would be well to have the instruments which have been found in the valley gravels brought together. There is one in Peel Park Museum, which a friend of mine found in a valley near Kirby Lonsdale. There is another somewhere in the neighbourhood of Middleton, if we can get it. It is one of the most highly worked I ever saw, and was found in the valley gravel somewhere about there. A collection of these would supply interesting material for discussion at another meeting. I think it would be a good subject for a paper, and at the meeting when it is read any of us may bring such specimens of the kind which we are able to collect.

Mr. Darbishire:—There is danger in instancing specimens found perhaps twenty years ago, owing to the difficulty of now ascertaining accurately the circumstances under which they were found.

Mr. Binney:—The general testimony is that they are found in the valley gravels. They were not thought of much value formerly. They were only considered to be indicative of great antiquity, but not such antiquity as is now assigned to them. I have often thought that the discovery of a cranoge at Castlefield has never been noticed sufficiently. It was underneath 18 or 20 feet of gravel, and was certainly part of a house made by human hands.

A vote of thanks to the Chairman terminated the meeting.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 5.] VOL. VII. [Session 1867-68.

The Monthly Meeting of the Members of the Manchester Geological Society was held at the Museum, Peter Street, on Tuesday, February 25th, 1868.

G. C. GREENWELL, Esq., F.G.S., President, in the Chair.

Mr. Devis drew the attention of the Society to a Stone Weapon which had been recently found in the till in a brickcroft at Collyhurst, at a height of nearly 150 feet above Mossbrook. It is on the slope near the lane which leads down from the Rochdale Road to the valley of Mossbrook, and is not more than fifteen feet below the level of Rochdale Road. I was on the spot half an hour after it was found, and made a most careful examination of the clay out of which it was taken. It was found in a little nest of sand, in a perpendicular position, the round end being downwards. There was not the slightest indica-

tion of the clay having been moved above it. The sand contained no admixture of clay, and its upper edge was unbroken.

Mr. Plant:—I have been to see the place from which the specimen brought by Mr. Devis was taken; the discovery seems to be an extraordinary one, if all said about it by the men working on the spot be true, that it was taken out of the boulder clay at a depth of two feet six inches or three feet from the surface.

Mr. Binney:—There is no reason why some of these weapons should not be found on the top of the clay as well as in the gravel. Some one may have been buried in this place and this may have been one of the weapons in use at the time. After a space of a thousand or even fifty years, it would be difficult to say whether the clay had been disturbed. I have known instances in which clay, filled into a hole or cutting, has settled down in a few years like the undisturbed clay, so that it was almost impossible to tell the difference.

Mr. Devis:—The difficulty is to explain the occurrence of the implement in such a spot, except on the supposition of its having been in some way or other buried there.

The Chairman:—It seems to be an ironstone; you may see in some parts the change from the oxidising of the ironstone, and then the oxidised iron seems to have been washed out and clay filled in its place.

Mr. Devis:—I have tested it for iron, but I got only the slightest indication of the presence of iron.

A vote of thanks was given to Mr. Devis.

GEOLOGICAL NOTES

MADE DURING A TOUR IN LEICESTERSHIRE;

By Mr. R. A. Eskrigge, F.G.S.

The county of Leicester, as a whole, is a tolerably level plain, with but slight surface undulations; the western half consisting of Trias, (chiefly keuper marls, with occasional beds of sandstone), and the eastern half of Lower Lias clays, the marlstone of the latter formation coming in on the eastern borders.

Towards the north of the county, however, there occurs a picturesque ridge, or rather succession, of hills, known by the name of Charnwood Forest, extending eight to nine miles in a north-north-westerly direction from Grooby and Bradgate Park, and rising to an elevation of from 600 to 800 feet. The central axis of this range is composed of syenite, which has been upheaved at some very remote geological period, and is overlain by rocks of either Cambrian or Cambro-Silurian age. These again are succeeded by Triassic beds, which lie upon them in marked unconformability.

On the western extremity of this disturbed district, the coal-measures are brought to the surface, and also a few detached outliers of Permian—both marls and breccia. Near to the Cambrian the carboniferous strata are much dislocated, and in some places lie almost vertically, so that the coals have to be extracted by following the beds down at a very high angle. Several of the collieries are sunk through the Triassic beds, which are found to thin out as they approach the Cambrian.

The chief geological interest centres upon the syenitic and slaty rocks above alluded to. The former are certainly amongst the oldest rocks of the British Isles, and have lately been assigned by good authorities to the Laurentian period, thus correlating them

with the gneiss of the Hebrides and north-west coast of Scotland, and also with the Malvern Hills. There certainly is a marked resemblance, both in mineralogical character and also in the appearance of the beds, between the syenite of the Malvern Hills and that of Markfield, Grooby, and Hammercliff. At Markfield the syenite comes up in a bold elliptical boss, and is extensively worked for road sets. The grain of the rock varies considerably: when very fine the crystalline structure is almost lost to the naked eye, whilst in some of the coarser varieties the crystals are well defined. The rock has a distinct cleavage, and when viewed on the face of the quarry, seems to lie in well-marked bands, suggesting the idea of stratification. In this it agrees closely with that of Malvern, which, as pointed out by Dr. Holl, bears strong evidence of being originally a stratified deposit. The cleavage is of great value to the working of the stone; the quarry men know at once the line of "cut," and the stone breaks easily along it. In breaking it the other way, the man nicks the block along, and then turning it over, it splits with a sharp blow. Along the cut or cleavage the crystals are flattened, so that the surface is almost smooth, whilst the other planes are rough.

Through the Markfield boss there runs a broad vein, varying from six inches to two or even three feet, of well crystallized compact carbonate of lime, generally coloured a reddish or flesh colour, the same as the feldspar of the syenite. This appears to have formed in a fissure of the syenite when overlaid by some rock now removed by denudation; perhaps mountain limestone, an outlier of which (the most southerly of the whole formation,) occurs a few miles to the north-west. Occasionally blocks are found in which the syenite and limestone are so intermingled that it is difficult to see how the latter has been formed subsequently, and looking at hand specimens, one would say the syenite had been injected into the limestone. Perhaps the true explanation is that the syenite has not fissured evenly along one line, but there have been cross fissures with narrow partitions, and these have

been all filled up with the lime. The hardest stone and that with the most perfect cleavage is generally found furthest from the surface—apparently because it has been subjected to the greatest pressure.

At Hammercliff the rock is a very finely grained and highly felspathic variety of syenite, with two cuts or cleavages, not so hard as at Markfield, and not therefore so valuable commercially.

At Grooby the rock closely resembles that of Markfield; but the cleavage is not so well defined. A vein of greenstone runs through the syenite, and appears to have changed the character of the rock in immediate contact with it, so that one would conclude the greenstone filled up a fissure in the syenite. All round the Grooby Hill the Trias marls lie upon the very irregular surfaces of the stone—giving the idea of very tranquil deposition.

Mount Sorrel is the most easterly extension of the pre-Cambrian rocks, and differs from all the others in containing distinct crystals of black mica, thus becoming a true granite. In other respects, both colour and nature, the rock closely resembles that of Markfield. There are numerous patches of hornblendic greenstone scattered through the granite: they do not appear as pebbles, but as though a predominance of one mineral had aggregated there under chemical affinity. These knobs are harder than the rest of the rock. There are also two veins of greenstone similar to that of Grooby alluded to above, on both sides of which the granite is more or less decomposed. It appears as though the greenstone originally filled a fissure in the granite; this afterwards opened again and was filled with a felspathic rock which has decomposed into clay, and in its decomposition affected the granite. Close to these greenstone veins the beds seem coloured by copper or chlorite. The granite has a double cleavage, and has a certain approximation to bedding, but not so clear as in the syenite at Markfield. It is much jointed, and broken into wall-like

cliffs many feet in height. Near the surface the rock has a tendency to decompose, and crumbles easily in places, resembling the China stone of St. Austell. About 600 hands are here employed in preparing sets for the London markets. On the eastern face of the quarry is a most interesting section, the beds of marl lying horizontally upon the granite, and filling up all its irregularities.

At Bardon, and one or two other points along a line running south-west to north-east, occurs a large mass of greenstone, merging into a felspathic rock. Here, in the quarries worked by Messrs. John Ellis & Sons, there does not seem to be any cleavage, though there is a faint approach to a stratified-like appearance. Owing to the absence of cleavage the stone cannot be used for square sets; but is broken by machinery into material for mending roads. The band extends right across the railway for some half mile further than is marked upon the Ordnance Map. The most interesting feature of the quarry is a fault of much altered slaty rock, about six feet in width. At the edges, in contact with the greenstone, the slate assumes the appearance of mica schist; and it looks as though a mass of slate had been caught up by the trappean rock and much altered by *contact with its heated* surfaces.

These were the only points at which I had the opportunity of examining the pre-Cambrian rocks, and without venturing in the present state of heated controversy on the subject, to express a decided opinion, the impression left on my mind was, that the syenite and granite were only extreme forms of metamorphosed stratified deposits, and that the *greenstone was the only true igneous rock of the whole range*, and belonged to a decidedly later geological age; most likely, from the evidence of the fault in the Bardon quarry, *to a later* date than the slate. So far as I could learn, both from my own observation and from enquiry, there is no point at which the slate can be seen in contact with the underlying rocks; though there are many places where the two are exposed within a very

short distance. The slates almost uniformly dip away from the older rocks. Near Bardon the slate is highly indurated from proximity to the greenstone; it frequently assumes a ribboned structure; at others it is of coarser texture and resembles quartzite, containing many solid pebbles of pure quartz, most of them small, but others of the size of a small egg. Mr. Joseph Ellis (a resident in the neighbourhood and a close observer,) assures me that he has seen in the slate pebbles of syenite. The quartz pebbles do not seem to have been derived from any rock in the neighbourhood now visible. The slates near Bardon have a very poor cleavage.

At Swithiland the cleavage is good; but the slates are coarser, and the rock jointed so that only small slates are obtainable; nowhere, so far as I could learn, have any traces of organic remains been found on the slates, and it is only upon lithological and stratigraphical grounds these rocks are referred to the Cambrian.

The thanks of the Society were given to Mr. Eskrigge for his paper.

Mr. Plant:—The geology of Charnwood Forest is perfectly familiar to me, from having been the field of many years' careful exploration before I came to Manchester. I differ from the opinion that the rocks have the slightest connection with the Laurentians, there are neither gneissic or serpentine rocks to be found throughout the entire district. The syenites are interbedded and stratified with the slates, and there is not any convincing appearance of igneous action, except in the traps and porphyries. In many instances the lines of contact between the syenites and the slates are converted into a greenish sandstone, and this has led to the conclusion, that after all these syenites are but metamorphosed sandstones. In the slates, instances are to be

found of pebbles of older rocks; and at Bradgate Park, small basaltic columns are to be found of metamorphic slate or greenish trap. Perhaps no better illustration of the nonconformity of strata is to be found than that at Grooby, between the syenite and the New Red marls. In many parts of the forest there are little patches of New Red sandstone which fill up the valleys. The only traces of organic remains which have been found in the slate rocks are the remarkable rings seen at Woodhouse Eaves, discovered by myself and the late Mr. James Harley, in April, 1848. They occur with two raised rings, commencing with a kind of projecting boss, going round, and varying in diameter from six inches to one foot. Professor Ramsay's opinion is that they were very likely spots where large seaweeds had been rooted, and probably by the action of the seaweed bending round by the force of the water, scooping out the mud in concentric circles. The hypothetical view of the geology of Charnwood is that it is related to the Welsh strata; but no specimens have been obtained from Charnwood Forest identical with those of the Cambrians from North Wales. In Professor Ansted's recent Memoir of the Geology of Charnwood Forest the subject is fully discussed, but not decided.

Mr. Binney:—From what I have seen of these rocks, I think there is no evidence at present whether they are Laurentian, or Cambrian, or Lower Silurian. No one professes to have found anything in the way of organic remains in them except these pieces of seaweed, and I think we have nothing beyond hypothesis respecting them. Before concluding that a hole has been scooped out by a seaweed, you must have some evidence of the existence of the seaweed itself. There are other parts of Leicestershire I should be glad to have some information about. I have been once or twice in that county since the Geological Survey published their map, and was anxious to learn something about the formation of the Moira coal-field; but, although I have consulted the map and made enquiries from local geologists, I have been a great deal

puzzled about the matter. I have observed there a true breccia over the Coal-measures, which, I am of opinion, is Permian; but there is a coarse sandstone in the Ballast quarry under this breccia and above the Coal-measures, which I wish for information about.

Mr. Plant:—Specimens of trunks of trees silicified have been found. There are no doubt beds of Permian in the neighbourhood of Ashby de la Zouch. The whole of this district is covered up with glacial drift of a local character; and some of the boulders of syenite from Grooby and Mount Sorrel are abundant on the western side of the hills of Charnwood. When the contractors were making the Ashby railway they had to cut through a deep deposit of this drift, and it appeared very much like the track a glacier would have formed, leaving a stream of boulders mixed with the clay. It extended twenty or thirty feet, where the railway cut it across diagonally. The conclusion arrived at was that it was an old moraine track filled up with boulders.

REMARKS ON AN

OUTLIER OF DRIFT-GRAVEL ON HOLCOMBE HILL;

BY MR. JOHN AITKEN.

IN the report of the recent excursion of this Society to Summerseat, read by Mr. Eccles, at the last meeting, reference was made to a bed of drift-gravel exposed in the face of a quarry opened in the rough-rock near to Peel Monument, at the southerly extremity of Holcombe Hill.

The unusual elevation of this patch of drift, its detached condition and peculiar position, are circumstances which will, I trust, be accepted as a sufficient reason for my bringing the subject

again before the Society in a more special manner, and at somewhat greater length than the writer of the report probably felt himself justified in doing on the former occasion.

My attention was first directed to the presence of drift-gravel in this position about eighteen months ago, and I have on several subsequent occasions visited the spot with the view of making further observations upon it. It is found at an elevation of about 1150 feet above the level of the sea, on the slope of the hill, a few feet below its summit, near the margin of the plateau succeeding the rugged and steep escarpment which forms the southerly termination of Holcombe Hill at this place.

This hill, which presents so prominent an object in the scenery of this neighbourhood and stands like a huge black sentinel overlooking the great South Lancashire Coal-field and the valley of the Irwell, as that river winds its tortuous course towards the Irish Sea, owes its striking configuration entirely to the presence on its summit of the rough-rock and the immediately subjacent flag-rock; the former of which here attains a development rarely, if ever, reached in this part of the county, or even in the North of England, where it is now known the carboniferous sedimentary rocks are found in greater force than in any other part of our Island. The area of this bed of drift appears to be of very limited extent, a careful search having failed to reveal the presence of foreign pebbles at the same level, either to the east or west of the position here indicated, in both of which directions the drift appears to vanish and die away at an elevation of from 950 to 1000 feet, a mean level to which these deposits generally attain along the sides of the valley of the Irwell and its tributaries in this locality; thus placing this small detached remnant of drift at an altitude superior to that of similar deposits in the surrounding district, to the extent of from 150 to 200 feet.

The following is a section taken in the quarry referred to, where the bed of drift is well exposed, and to better illustrate its true position, the subjacent rough-rock and flag-rock are also included:—

	FEET.	INCHES.
Surface Peat	0	6
Yellow Sand, with small angular pieces of sandstone	0	6
Dark Brown Fine Sandy Loam	1	6
Drift-Gravel	0	9
Sand, with angular broken-up pieces of sandstone...	2	0
Upper Rough-rock	66	0
Coal, Sand-rock or Feather-edge Mine	1	2
Shaly Under-clay	1	0
Lower Rough-rock	30	0
Shale	0	10
Indifferent Shaly Flag-rock, or strong shale ...	2	2
Flag-rock, presenting rough, scaly, ripple-marked surfaces, when split open blueish in colour...	16	0
Shale, very thick	0	0

On collecting 100 pebbles from the gravel *in situ*, I found them to consist of the following rocks:—

34 Coarse Carboniferous Sandstone.
21 Greenstone and Trappean Rocks.
17 Fine Grey Soft Sandstone; probably of Carboniferous age, but not derived from the immediate locality.
14 Quartz and Quartzites.
9 Fine Red and Brown Micaceous Sandstone; probably Carboniferous, but not found in the locality.
3 Granite.
2 Porphyry.

100

In addition to the above, I picked up the following pebbles from a heap of gravel which had been thrown out in removing the surface accumulations when excavating for the rough-rock, viz:—

1 Flint.
1 Chert.
1 Felspar.

I may also add that one of the greenstone pebbles taken from the same place by Mr. Eccles, exhibited slight but unmistakeable traces of scratches or striæ on its surface.

From the foregoing list of pebbles the identity of the gravel as one of true drift age will at once be apparent.

It is not my intention on the present occasion to offer any speculations as to the special causes which might be assigned for the presence of this outlier of drift in so elevated and exposed a position; but shall content myself with thus simply placing the facts before this meeting.

Since writing the above my attention has been directed by Mr. Eccles to the "Memoirs of the Geological Survey of the Bolton District;" wherein Mr. Hull records an instance of erratic pebbles occurring on Winter Hill at an elevation of 1380 feet, or 230 feet higher than the Holcombe Hill deposit, and from 380 to 430 feet above the general level in east Lancashire; this is, therefore, undoubtedly the highest recorded instance of the occurrence of drift in Lancashire.

In the section just presented it will be observed that the rough-rock and flag-rock are separated by about ten inches of shale. In another section, however, exposed a few hundred yards to the north-east of Holcombe, the rough-rock rests directly upon the flag-rock, so that the two become incorporated at the line of

contact. It would appear that the deposition of the overlying rock took place whilst the substance composing the flag-rock was in a plastic or yielding state, as the quartz pebbles of the former have indented the upper surface of the latter, and partially buried themselves in its substance. The two specimens on the table will illustrate the juncture of the two rocks, and the indentations of the surface of the flag-rock. The disappearance, at this point, of the separating bed of shale, exhibits in a remarkable degree the variation of strata which sometimes takes place in the carboniferous rocks, in a very short distance. Whilst at Holcombe there is no representative, or at most a very feeble one; it attains, at a distance of about five miles to the north-east, on the slope of Cribden, near Crawshawbooth, an unusual development, reaching the vertical thickness of 310 feet. Taking the various sections of the district, the average thickness may be put down at about thirty feet.

The thanks of the Society were accorded to Mr. Aitken for his paper.

Mr. Binney:—I can only say that this drift is at a greater elevation than I have seen it myself. I have not been on the top of Holcombe Hill; but I have seen the drift a little higher than Haslingden Road. I was not aware that Mr. Hull had observed the occurrence of drift on Winter Hill. It seems probable that we shall find this drift higher still,—at an elevation of 1300 or 1400 feet. What Mr. Aitken states about the singular erosion of flag-rock and the deposition of the strata, is frequently exemplified in parts of Yorkshire. Probably a large portion of the flags had been swept away before the deposition of the other rock.

Mr. Eccles:—Near Sabden I have observed the rough-rock lying unconformably on the shales above the Haslingden flags. These

shales are eroded in hollows, in which the rough-rock has been deposited later; shewing very clearly that the shales have been subjected to considerable denudation previous to the deposition of the overlying rocks.

Mr. Binney:—In the neighbourhood of Bury you sometimes find above the Feather Edge coal several feet of shales full of plants. Within a mile or two of that spot there is no trace of these shales; they seem all to have been swept away, and a coarse sandstone deposited in their place. It is an extraordinary instance of denudation in the Lancashire coal-field.

Mr. Eccles:—I wish to bring before the notice of the Society, an occurrence of glacial striæ and polishing which I have discovered at Mellor, between Blackburn and Preston. The reason why I mention this instance is because the direction of the grooving is different from that which was recorded at a previous meeting. At that meeting it was stated that the groovings then referred to varied in direction from north-west to north. In the instance to which I now call attention the direction of the groovings is ten to twelve degrees north of east. There seems to me to be a reason for this. The groovings occur near the base of the hill, on its north-west face, where the dip of the strata is also north-west; whilst on the opposite side of the hill the dip is south-east. The striæ run in the direction I have stated, and seem as if they had been deflected, owing to the hill forming a kind of promontory and the ice having, apparently, struck against it and gone along its side.

Mr. Plant:—Is it mountain limestone?

Mr. Eccles:—No; it is the Kinder Scout Grit: the hill is the one on which the Roman camp is situated.

Mr. Binney:—On the surfaces of the sandstone at Liverpool, which Mr. Morton shewed me, were cross striæ in an easterly direction. With this exception, I have never heard of any striæ having the same easterly direction which Mr. Eccles speaks of.

Mr. James Hibbert, of Ashton, exhibited a model of a Self-Acting Brake, to prevent overwinding from Coal-shafts.

The thanks of the Society were awarded to the exhibitor.

The meeting terminated with a vote of thanks to the Chairman.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 6.] VOL. VII. [Session 1867-68.

The Monthly Meeting of the Members of the Manchester Geological Society was held at the Museum, Peter Street, on Tuesday, March 31st, 1868.

E. W. BINNEY, ESQ., F.R.S., F.G.S., in the Chair.

REMARKS ON A

STONE AXE FOUND IN THE VALLEY OF THE MERSEY,

AT FLIXTON, NEAR MANCHESTER, IN 1846;

BY MR. JOHN PLANT, F.G.S.

In a Society like this, it is evident that the principal aim of its Members should be to observe and describe every feature which may be incident to the Mining, Geology, Palæontology, and Archaic Anthropology of the wide district of which Manchester is the

centre; and it is also desirable that a statement, however brief, of every new or unrecorded fact connected with these subjects, ought to find its place in the pages of the Society's proceedings.

The subject of local Archaic Anthropology has hitherto never recommended itself to the attention of the members, or found such favour as its importance and interest have excited for it from others residing in more highly favoured localities, where implements of flint, worked and polished stone weapons, are abundant in the gravels and peat beds, and are easily acquired.

The north-western districts, especially of Lancashire and Cheshire, have hitherto proved to be barren of the chipped flint implements of such high antiquity as the high-level valley gravels yield in the East and South of England; and the district is also comparatively barren of all objects of the pre-historic ages of stone, except a few, such as are now regarded as belonging to the irregularly occurring weapons of the Neolithic or later-stone ages. It may be, also, that others have been destroyed or lost, simply from ignorance of their value by labourers and workmen.

It is from these considerations that I seek to place upon record the facts connected with the finding of this remarkably fine sample of a polished stone weapon, as well as to append an imperfect list of others found at various times within this district.

This stone hatchet was found in a field at Flixton, five miles south of Manchester, in April, 1846. Mr. Charles Royle, Surveyor of Highways, being present at the finding, became the possessor, for a trifle to the labourer. Soon after it was placed in the hands of Mr. John Davies, an eminent Chemist and Antiquarian, of Manchester; and at his decease, it was sold at an auction for half-a-crown. It passed into the possession of Mr. R. H. Brackstone, an Archæologist, of London and Bath, from whose hands it was ultimately purchased with his large collection

of pre-historic objects, by the founder of the Blackmore Museum, at Salisbury, where it is now to be found.

The first description which appeared in print of this stone weapon is the following:—At a meeting of the Archæological Institute, London, November 1st, 1850, "Mr. Brackstone "exhibited a stone celt of large dimensions, weighing 2lbs. "13½ozs., found about April, 1846, in a bank of gravel called "'The Carrs,' on the estate of Shaw or Shagh, Flixton, near "Manchester. It lay at a depth of eight feet, and was brought to "light in digging gravel under the direction of Mr. Charles Royle, "who had presented the celt to a gentleman in Manchester, "recently deceased. The bank appears to have been formerly the "shore of the Mersey, which flows at a short distance near its "confluence with the Irwell, and the flat meadow-land between "this bank and the river is protected from floods by earthworks, "termed locally 'fenders.'"*

This account of the stone celt was regarded at the temporary exhibitions of the Archæological Societies, where it was often shewn, as relating more to its antiquarian significance than to its bearing upon geological science; and very probably the circumstances connected with this stone celt would have passed into oblivion, like hundreds of such events, had it not been resuscitated during a controversy in June, 1867, as to the correctness of an alleged finding in a gravel bed nine feet deep, at Malton, of a somewhat similar but much smaller stone axe.

Mr. E. T. Stevens, the learned Custodian of the Blackmore Museum, published a letter in "The Times," submitting his doubts as to the accuracy of the reported position of the axe in the gravel at Malton, and, referring to the stone hatchet at Flixton as a case in point, asked for further inquiry into the age and character of the

* Jourl. Arch. Inst., vol. vii.

gravels in which it was stated to have been found. He writes "There is a fine stone hatchet in the Blackmore Museum, about "13in. long and weighing more than 3lbs., which was dug up at a "depth of eight feet in gravel at Flixton, near Manchester, in a "field called 'The Carrs,' near Shaw Hall. The gravel was being "dug for mending the roads. From the description given of this "gravel bed, it appears probable that it was deposited at some "remote time by the Mersey, which flows at a short distance, "with very flat meadow land between. The Flixton hatchet is "of the usual Neolithic form, and stained from remaining in the "gravel. This discovery is in many respects similar to that so "recently made at Malton. The first thing to be done in order to "render the discoveries at Malton or Flixton of value to science, "is to determine the age of the beds themselves; the presence "of a bone of an Ox, split lengthwise, in the Malton gravel, "tells against the extreme antiquity of the deposit rather than "the reverse; for animal remains found in the river gravels "(Pleistocene drift) have not been split as if for the extraction "of marrow, which appears to have been the case with the bone "at Malton."

As the recorded position of the Flixton hatchet in this bed of gravel was of importance, and as its reported position also militated against the views of Sir John Lubbock, and other high authorities in their divisions of the relative ages of the pre-historic stone weapons, it was desirable that a more careful examination of the gravels and terraces of the valley of the Mersey should be made, as probably in 1868 a Geologist might be able to regard the valley gravels and river deposits in a very different light from that seen by the Archæologist twenty years ago.

I therefore early in the present year paid several visits to the locality, and on one occasion was accompanied by Mr. Charles Royle, whose memory is unusually retentive and fresh as to the facts which occurred on the day the hatchet was found, now 22 years ago. He

very kindly related the details, which are not many, and pointed out as nearly as possible the spot where the labourer shovelled the hatchet from the ground, so that I was fortunately deprived of the pleasure of indulging in any conjectures upon the subject, by having the clear and satisfactory evidence of an eye witness in Mr. Royle.

To understand the position of the hatchet, it will be of some assistance to those who are not familiar with the district, to describe the features of the valley gravels and river terraces near the junction of the River Mersey with the Irwell, upon which my own observations are simply corroborative of the description given by Mr. E. Hull, F.R.S. He writes as follows:—

"Persons who have crossed the ground on both sides of the "Mersey, from Old Trafford to Altrincham, cannot fail to have "observed the extreme flatness of the country; I have frequently "remarked it myself, and was aware that in some parts of it there "was a layer of gravel or sand, but was unaware whether this "gravel belonged to the Northern Drift or was of more recent "origin. Not long since I commenced to trace its margin, and "found that it occupies a considerable extent of country, and is "either an estuarine deposit, at a period when the land was at a "lower level, or as Professor Ramsay supposes, is an old river "terrace of a period when the rivers Irwell and Mersey had a "much wider range than at present. The gravel lies for the most "part on the lower boulder clay, and is composed of small pebbles, "well rounded and generally evenly bedded; sometimes it passes "into fine sand, white or ochreous. It is exposed to view in a "brick yard at Urmston, resting on boulder clay, and forms a "terrace about thirty or forty feet above the alluvium of the "Mersey."*

* On the Geology of the Country around Oldham and Manchester, page 53.

This gravel deeply covers the country between the rivers Mersey and Irwell, whose ancient valleys of level land ("Carrs,")* vary in width from 500 yards to above a mile, in the midst of which the present muddy currents are running in deepish tortuous channels. These wide level valleys have been worn through the gravel, and perhaps into the underlying boulder clay, although the latter is nowhere exposed, being covered up with a talus and disturbed warp. The existing narrow river channel is worked out of laminated beds of warp, very deep in some places, generally a dark-brown loamy sand without pebbles. The level carse land appears to be entirely composed of this warp. All these clays, gravels, and warps, rest upon eroded surfaces of lower Keuper sandstone, which are seen in section at some of the river bends. The carse lands would be covered with water during floods in the Mersey, were it not for the high *levees* of earth raised along the river banks; as it is so well protected, flood waters very rarely, if ever, spread over the whole of the level valley. The section of the gravel mentioned by Mr. Hull, in the brick-field, is not so interesting as is the one 300 yards to the west of Urmston Old Hall. A good deal of gravel has been excavated here, but the gravel pit is only kept open to about twelve feet, just sufficient for a cart to stand in. As it is opened on the east face of the river-terrace, it affords a good inspection of the gravels for their depth, composition, and colour. A sharp bend in the river brings it within 100 yards of this gravel-pit bank, which rises abruptly twenty feet from the level carse land.

The section of the gravel pit, is for a depth of eleven feet, consists of:

1st.—Fine sandy loam with very few pebbles, the lower part passing into sand, from two feet to three feet six inches.

* Carse, (of Gowrie,) *Scotch*, flat land adjacent to a river, or arm of the sea. Carre, a hollow place in which water stands.—*Grose & Pegge.*

"Carrs," a piece of flat, marshy ground, a small lake; *Kaer*, a bog.—*Brockett.*

2nd.—Coarse sand with irregular oblique layers, and red bands of oxidised, fine gravel and sand traversing the layers, about two feet six inches.

3rd.—Gravel in deep red sand, with pebbles and boulders of old rocks, derived from the boulder clay, about ten inches.

4th.—Coarse sand in oblique and irregular layers, with a few pebbles, and lighter red than the upper layer of sand.

After a careful search both here in the gravel-bank, and elsewhere on the ploughed lands, I was not able to find any but natural water-worn stones, the greater number of which had evidently been anciently washed from the glacial clays. The syenites, traps, and slates, coal pebbles, and carboniferous limestones, are very common.

The exact locality where the hatchet was found is half a mile to the west of this gravel bank, and in another of the bays formed by the projecting banks of gravel on to the carse, it is about the same distance from Shaw Hall further to the west. The banks surrounding this bay rise very gradually from the level, and are composed of a deeper layer of the first sandy loam; the gravel is not so consistent and scarcely displays itself through the loam. The mixed silt and warp, which lies like a talus up the gentle slope and to the top of the terrace, is here not more than eight feet above the level of the carse. The deposits and rearranged material all about the place partake much more of the character of the warp than of the gravels, and whatever may belong to the gravel has the appearance of later disturbance and redeposition. As far as any "gravel-bank eight feet deep"—such as is mentioned in the account by Mr. Brackstone—is concerned, I can give a positive affirmation that no such deposit is to be found on the spot: and this is corroborated by the testimony of Mr. Royle, who informed me that the material used to fill up the hollow on the road to the village, was got by working along the slope of the bank on the level of the carse, and consisted of loamy rubble of a loose nature,

and that the hatchet or axe was shovelled up in this stuff almost level with the flat land. The men never worked into the bank far enough to reach a clean bed of the gravel, and had they done so, it would only have been to find a thin bed of it at the bottom of a sloping bank, in a face of about six feet deep.

This stone hatchet is of unusual size, being thirteen inches long. It is well shaped, oval in form, and in the opinion of Mr. Franks, of the British Museum, of Mr. John Evans, and Mr. Stevens, is allied to the Danish type of stone hatchets, probably of the age of the Kitchen-middens*. Its colour is yellowish brown, a superficial colouring derived from the warp it was found in; the surface is much aged and corroded, beneath the stone has a greenish colour, but is neither a greenstone trap nor a slate, it is very difficult to judge of the true lithological nature of these weapons without fracturing them, and in rare specimens this is more than we can expect the possessors to allow. However, as the present inquiry is not a question of composition but one of identity of position when discovered, and of consequent conclusions as to the age of the deposit in which it was found, I think that the whole of the evidence I have been able to produce will be regarded by competent judges in these matters, as entirely negatory as to the alleged position in the deep Pleistocene gravel, and confirmatory of its being a surface specimen, lying in a deposit of warp of more recent age. This is quite in harmony with many known instances of undoubted position of this type of polished stone hatchet in the countries where they have been more commonly found, and is also in confirmation of the opinion of many high authorities upon the relative ages of pre-historic weapons, viz:—that rubbed stone weapons although of great antiquity, are yet subsequent to the Palæolithic weapons of the rudely chipped and unpolished flints which are found in valley-gravel deposits alone.

* At a recent visit to the British Museum I observed two specimens of stone hatchets labelled "Isle of Skye" which are much like the Flixton hatchet.

LIST OF SOME OF THE STONE WEAPONS

KNOWN TO HAVE BEEN FOUND IN LANCASHIRE AND THE NORTH-WESTERN DISTRICTS.

A Weapon of dark Stone, of the hatchet form, from a moss near Martin Mere; figured in Leigh's Natural History of Lancashire, 1700.

A large Gritstone Hammer or Sledge, with circular helve hole, twelve inches long, at Throstlenest, Manchester; figured in Whitaker's History of Manchester, 1771.

A large Stone Hammer, found at Tabley, Cheshire; mentioned in Itin. Curios. page 54.

A Stone Hatchet, from the Lake-district, dark slate, four inches long; in the Salford Museum.

A Stone Hammer of ironclay stone, from Greenhill Farm, Tatham, near Lancaster, found in 1853, by Mr. T. Hall; in the Salford Museum.

A Stone Hammer, of gritstone, from near Darwen; exhibited by Mr. Parker at this meeting.

Two polished Stone Celts, found in a level of "old moor workings," in a Hematite ore mine, at Stainton; one in the possession of Mr. J. H. Jackson, Solicitor, Ulverstone, 1866.

Portion of a Stone Axe and a fine Flint Flake Knife, with two other Stone Implements; taken from the floor of Kirtshead Cave, near Ulverstone, by Mr. Bolton and Mr. Morris, in 1864.*

A Stone Hammer, from the soil under the floor of a stable at Oubans Cottage, Ulverstone; by Mr. Wilson, 1868.

* The first Flint-Flake found in these districts. This specimen of axe is of the Danish type.

A small Stone Hammer, of dark green colour and very finely polished, found in the gravel at Middleton, in the possession of Mr. Shaw, of Saddleworth; also a small Stone Hammer of a dark grey colour, found by Mr. Shaw, in the valley-gravel in the valley of the Tame, near Upper-Mill Railway Station: exhibited by Mr. Binney at this meeting.

A fine Stone Hammer, of clay iron-stone, found in February, 1868, in the clay at Harpurhey; exhibited by Mr. Devis at this meeting.

A Quoit-formed Implement, six inches diameter, with a hole 1¼in. in the centre, found in drift about twenty feet from the surface, under the railway station at Staleybridge. The material is much like an iron-clay cement, and has the character of moulding rather than rubbing or grinding. The weight is four pounds eight ounces, and its specific gravity exceeds that of a piece of trap of equal dimensions: it resembles the fishing net weights which come from the Lake dwellings of Switzerland; in the collection of Mr. J. Woolven, Station-Master, Ashton, near Manchester.

A Ring of Stone, of smaller size, was found in 1866, in the gravel at Macclesfield, and is in the collection of Dr. Sainter, of Macclesfield.

A Stone Hammer found near Clitheroe, and two Stone Axes; exhibited by Mr. R. M. Knowles at this meeting.

A massive Primitive Weapon of Trap, from North Wales, of the type of weapons found in the Isle of Skye, by Dr. James Hunt. This weapon has been hewn into a mallet form by striking off angular pieces. The surface is weathered, and has every appearance of great age. Found on the surface of the ground near Penmaen; exhibited by Mr. R. D. Darbishire at this meeting.

A thick oblong Disc of Gritstone, somewhat like a small cheese with the top and bottom sunk from the edge; also from North Wales, and exhibited by Mr. R. D. Darbishire. Its use was unknown.

Two Stone Hammers of large size, evidently of local origin, exhibited by Mr. Horn, of Oldham.

The thanks of the Society were given to Mr. Plant for his paper.

An animated discussion ensued, in the course of which, in reference to some remarks by the Chairman on the discovery of a "Crannoge" at Castlefield, in 1820, (of which an account had been published by Mr. Francis Looney,) Mr. Plant contended that the structure in question could not with propriety be termed a "Crannoge," but was probably of an age posterior to the deposition of the gravels under which it reposed. Adducing as arguments in its favour, its small size, and the opinion of local antiquaries as to its position, he considered that it was the wooden brattice of an old well which had, at some unknown date, been sunk into the gravels.

The Chairman was strongly opposed to this explanation on the ground of the extreme improbability of a well having been sunk in strata where no water could be found, and because the evidence of contemporary observers was to the effect that the overlying gravels had been found perfectly stratified and undisturbed.

The Meeting terminated with a vote of thanks to the Chairman.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 7.] VOL. VII. [Session 1867-68.

The Monthly Meeting of the Members of the Manchester Geological Society was held at the Museum, Peter Street, on Tuesday, April 28th, 1868.

G. C. GREENWELL, Esq., F.G.S., President, in the Chair.

NOTES ON THE

CAVES ON THE BANKS OF THE VEZÈRE,

OF THE DORDOGNE DISTRICT;

COMMUNICATED BY RICHD. CHRISTY, ESQ., OF POYNTON.

The researches which brought to light these stone implements and other traces of early man, were carried on by the late Mr. Henry Christy, from 1863 to 1865, assisted by his friend the well-known French comparative anatomist and savant, Mons. E Lartêt.

The rocks in which they occur are of a soft limestone, referable to the cretaceous formation, and cannot fail to arrest the eye of the traveller passing along the railway from Perigueux to Agen, a district quite unknown to ordinary tourists until the opening of this line of railway.

The cave-shelters, or overhanging rocks, where these remains were discovered, are at heights above the present bed of the river varying more than 100 feet. The aspect chosen is almost invariably the southern one.

In some of the caves the remains formed a solid mass of breccia, apparently the rocky bottom, until lifted and torn up by crow bars. In others, where there had been less petrifaction, they formed a looser deposit. A specimen of this breccia accompanies these notes, in which both Reindeer bone, worked flakes of stone, and charcoal, are massed together. No bones of any domestic animal have been found at any of the five stations examined.

Amongst almost countless quantities of worked flints found and examined, not one presents any artificial polish, such as is so frequently offered on stone implements discovered elsewhere, associated with traces of domestic animals and of agriculture.

The bones found are, broadly speaking, those of the Reindeer in by far the largest proportion, next to that, those of the Horse, and also the Aurochs; but in all the stations the first two have been the prevailing food. Other bones, including those of Birds and Salmon, are present also. That the caves were inhabited the year round is inferred by the bones and horns of the Reindeer exhibiting specimens of every age and season.

The worked flints or flakes are chiefly from flint, or a sort of chalcedony, and specimens accompany these notes, shewing a great variety of delicacy and manufacture, from extremely short delicate points to the blunt round-pointed scraper, chipped into that form, and closely resembling a stone implement but recently in use by the Esquimaux for scraping skins.

Two matrixes or lumps, from which flakes have been struck, are also exhibited, shewing the numerous facets caused by the

repeated detachment of preceding flakes; facets which the backs of the flakes themselves constantly exhibit.

The worked bones and etched or scratched slate or stone are most interesting. Pieces of real bone and one horn of a young Deer which distinctly shews marks of cutting where the skin has joined the horn, are exhibited. Also some careful and most accurate fac-similes in plaster of some of the bones, chiefly Reindeer horn, which bear traces of rude ornamentation as well as positive fashioning into implements, such as harpoon heads, and other forms not so easily referable to use. Several bone needles with bored eyes have been discovered. They nearly approach to ivory, and it is believed are taken from the shin bone of the horse.

To assist in defining the position of antiquity of these cave dwellers, it may be remarked that no trace of the Reindeer has been found in any of the oldest Lake dwellings of Switzerland, nor in other cave dwellings referable to the same period.

These very detached and crude notes are jotted down from recollections of conversations with the late Mr. H. Christy, and more recently with Mons. Lartêt, and also from reference to the descriptive work entitled "Reliquiæ Aquitanicæ," now published by Mr. H. Christy's executors.

A most interesting study of stone implements of all periods, and of the remains from the caves to which these notes refer, may be made at the Museum, 103, Victoria Street, Westminster.

The worked and ornamented bones from which these models are made, were chiefly deposited by Mr. H. Christy, in the Ethnological Museum of France at St. Germains.

The thanks of the Society were given to Mr. Christy for his paper.

Mr. John Aitken, in presenting to the Society, in the name of Edward Hull, Esq., F.R.S., the Horizontal Section of Mid-Lancashire, observed that this section had been prepared by the above-named gentleman, to illustrate a paper read at Dundee, at the recent meeting of the British Association, on "The Relative Ages of the Principal Physical Features and Lines of Disturbance of the Carboniferous District of South and Mid-Lancashire."

The section stretches across the hilly country lying between the great South Lancashire coal area on the south-east, and the carboniferous limestone district of Slaidburn, in Yorkshire, on the north-west, a distance of upwards of twenty miles.

The object of the writer of the above-mentioned paper was to point out, that in the district traversed by the line of section, certain disturbances of the strata have taken place at various periods, resulting in a number of parallel elevations or anticlinals, with their resultant intervening depressions or synclinals, the general direction of which is from north-east to south-west. In the paper referred to, Mr. Hull writes:—"Thus we find that the beds of this part of the country (Mid-Lancashire) have been thrown into a series of foldings along east-north-east and west-south-west lines, by the exertion, it may be supposed, of lateral pressure, which appears to have acted with the most marked results along the line of the Pendle range, and three actual foldings may thus be traced."

The first or south-westerly flexure, named the Anglezark or Rossendale anticlinal, passes along the north-westerly side, and forms the boundary of the South Lancashire coal-field, and extends

from Rivington through the Darwen, Holcombe and Rossendale Hills, and terminates at the great line of fault running among the great Cliviger gorge. This line of upheaval is composed principally of members of the millstone grit series, and its form may be described as that of a "flat arch," from which the strata dip respectively towards the South Lancashire coal area to the south, and towards the north to the deep trough or synclinal in which the Burnley and Blackburn coal-basins are situated. To the north-north-east of the Burnley trough, the Clitheroe anticlinal occurs, the axis of which has a direction roughly coincident with the valley of the Ribble. This upheaval brings to the surface the carboniferous limestone, a considerable body of which is exposed at Clitheroe and in the surrounding locality; from this axis of elevation the beds plunge at a high angle under the Burnley coal-basin to the south-east, and under the Yoredale and Millstone grit rocks of Longridge Fell to the north-west. This range of hills follows the next line of depression, and separates the Clitheroe from the more northerly or Slaidburn anticlinal, where the mountain limestone is again repeated, and occurs along the line of axis in considerable force.

It is therefore evident, from the sketch here presented, that the strata of the district under consideration have been thrown into a number of wave-like undulations, which succeed each other as we travel north-west from the principal coal-field of Lancashire; and although "these flexures are somewhat disarranged in places by transverse faults, they are, upon the whole, well expressed, and explain the structure of this part of South Lancashire."

Before leaving this neighbourhood for Scotland, Mr. Hull kindly placed the section in my hands, and at the same time desired me to make whatever use of it I thought most desirable. As I conceive that it possesses considerable value as a contribution to local geology, and may serve as a work of reference, I have much pleasure in presenting it, in the name of Mr. Hull, to this Society.

NOTES ON THE

ORIGIN AND STRUCTURE OF A FLINT PEBBLE

FOUND IN THE DRIFT ON HOLCOMBE HILL;

By Mr. John Aitken.

At the meeting of this Society held in February last, when making some remarks on an outlier of drift discovered on Holcombe Hill, I exhibited a number of rock specimens taken from the bed in question, one of which I described as a flint pebble. At the conclusion of the paper, it will be remembered, an animated discussion took place as to the origin and character of the pebble; some contending that it was a piece of water-worn chert, whilst others held that it was a true flint. In consequence of the diversity of opinions expressed, I deemed it advisable to subject it to a thorough examination, with the view of testing and placing beyond doubt its true character and derivation. I have therefore, with the assistance of Mr. Plant, who has rendered me valuable assistance in conducting the microscopical investigation, been enabled satisfactorily to accomplish this object; the result of which is, conclusively to establish the correctness of the description I then gave, viz:—that it is a "true chalk flint." On splinters from the pebble being mounted and subjected to the microscope, it was found that they revealed a rich profusion of fossil forms of great variety, having a true cretaceous facies, some of which are very distinct and in a beautiful state of preservation.

An enlarged representation of the objects presented in the field of the microscope, has been prepared and is now submitted for examination. The mounted object, from which the sketch has been taken, is also produced and may be viewed in the microscope, which has been kindly lent by Mr. Plant for that purpose.

The following is a brief description of some of the most prominent and characteristic forms contained in the mounted slide, and which have been reproduced in the accompanying sketch.

The Holcombe drift pebble is about the size of a small walnut, of a yellowish colour, smoothed and fairly polished, with an external coating of a creamy colour. When fractured the colour is smoky and the matrix semi-transparent, with dull whitish specks floating in it. When a thin splinter is examined by a pocket lens, there can be detected numerous elongate tapering forms of a milky-white colour; but a fragment ground and polished and seen under a high power of lens, becomes very interesting, as the true nature of the embedded bodies becomes revealed into sponges, polythalamous shells, crystals, and other organisms.

The largest of the sponges are about $\frac{1}{80}$th part of an inch long, shaped like tapering elongated tubes, the surfaces marked by spore holes and often coated with atoms of dirt. Most of these sponges are torn and damaged, but with the portions in juxtaposition. Some sponges are like little bladders, with a hole in the side as though they had burst, and others like a wide short-necked flask; fragments of sporules and spiculæ of these sponges are abundant: One prominent object in the fragment of flint operated upon, is a flask-shaped sponge of a deep red colour, embedded in a cloudy patch of algae or discoloured silica; the red colour may be only acquired from oxide of iron, but it serves to give great distinctness to the object in the midst of so many white and transparent forms. Near to this sponge occurs a specimen by which the pebble is determined as belonging to the age of the cretaceous formation. Seen under a quarter-inch lens it looks like a beautiful cyclostomoid shell of dull red colour, slightly opaque; the rounded whorls are separated by clear transparent lines, which have the effect of making the whorls look globular when seen under a strong reflected light. The shell is about the $\frac{1}{100}$th part of an inch

in size, and agrees with a genus of Polythalamia found in the chalk flints in the south-east of England, known by the name of Verneuilina*

The species to which this shell should be referred is not satisfactorily decided. It may possibly be one undescribed, or at a different age of growth to those figured and described; but, that it is a specimen of Verneuilina there can be no doubt whatever. There are other forms of these minute Polythalamous shells in abundance; such as Nodosaria, smooth and ribbed; Rosalina; a discoidal shell, like a Nautilus; Lituola, Dentalina, and Textularia; all of which are allied to well-known species found in chalk flints; besides these pretty-well defined species are fragments of others, with sporules of Xanthidia, buried in patches of cloudy matter, delicate films with beautifully granulated and reticulated markings, minute crystals of quartz, and shell prisms, all of which still further prove that this flint pebble belongs to the age of the chalk.

In the three other flint pebbles from the drift at Bacup, there occur many specimens of sponges, similar to those found in the Holcombe pebble; with shells like Nodosaria and Textularia, fragments of sponges, shells and cloudy-white matter, but these are more thinly distributed and not nearly so abundant: quite sufficient, however, to prove them to be true chalk flints.

In Messrs. Hull and Green's Memoir of the Geological Survey, —Geology of the country round Stockport, &c., page 79—special notice is taken of the finding of one large yellow-coated flint in the gravel of the river terrace, shewing how unusual is the occurrence of flints in the drift of this part of the country.

A vote of thanks was given to Mr. Aitken for his papers.

* See Mantell's Medals of Creation; Murchison's, De Verneuil, and Keyserling's Geology of Russia; Williamson's Recent Foramenifera.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 8.] VOL. VII. [Session 1867-68.

The Monthly Meeting of the Members of the Manchester Geological Society was held at the Museum, Peter Street, on Tuesday, May 26th, 1868.

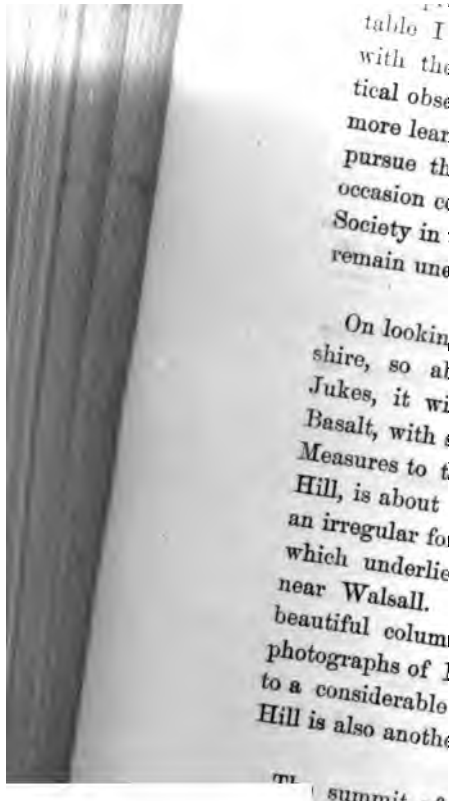
G. C. GREENWELL, Esq., F.G.S., President, in the Chair.

The following paper was read—

ON THE GREEN ROCK AND BASALT OF THE SOUTH STAFFORDSHIRE COAL FIELD;

BY MR. HENRY JOHNSON, DUDLEY.

FROM the great profusion in which both these rocks abound in the South Staffordshire coal-field, to do full justice to the subject, would exhaust the time of many meetings like the present one, and therefore, with your permission, I propose to give you more a practical illustration of the subject, than that of a minute scientific investigation of the phenomenon of intrusive Trap.



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explorations have at present proved, this Basaltic Rock may be compared in model to a flat-topped mushroom without the stem. No doubt a central pipe or pipes of Basalt do exist, but the present busy band of steady workers underneath it in the Thick coal would be only too glad to know where. The new Netherton Canal Tunnel, two miles in length, was cut right through this range, from side to side, without, however, meeting with any Basaltic Rock at all, except as loose boulders. This tunnel is driven through at 484 feet above sea level, and cost £200,000.

Underneath and passing through the Thick coal, in the neighbourhood of the Rowley Hill, is a bed of Green Rock which is believed to extend in unbroken continuity below the Thick coal, in wide tracts across the country, and connecting all the before-mentioned domes of Basalt with the supposed parent mass at Rowley Hill. How far this may be correct it is not for me to say, but I have grave doubts about it. I think this intrusive Green Rock would have found a far readier vertical outlet through about 200 yards of covering of Coal-Measures, than to have been injected horizontally six miles (viz: to Powke Hill) into the same Coal-Measures. In other words, it is as the resistance of 10,560 yards of horizontal strata against 200 yards thick of vertical strata. True it is that the Green Rock has been traced nearly continuous throughout the six miles, but it may also be quite true that within that six miles there may be many pipes or feeders coming up from below which have not as yet been discovered, and which supplied the Green Rock before alluded to. This "bed," or perhaps what would be a better term, "streak," or vein, of Green Rock—having its minor off-shoots in every conceivable shape—ranges in thickness from a few feet to twenty-five or thirty yards. It traverses a portion of the district, sometimes nearly at the base of the Coal-Measures immediately above the Silurian shales, (which form the base of the whole of the South Staffordshire coal-field;) at others, it lies below the Bottom coal, then passing through the Bottom coal runs above that seam, and at some

places passes up into the Thick coal, and even off-shoots of it pass up into the Brooch coal, as will be seen by the specimens before you. Where this Green Rock is a great thickness, it assumes all the appearance and characteristics of true Basalt, and attracts the magnetic needle, very often producing great errors in dialling the workings of the mines in which it occurs. It also has the effect of cokeing as it were, and rendering almost useless for any commercial purposes, any coal with which it is found in close contact, and this occurs sometimes for a considerable distance on all sides of it—whether top, bottom, or sides. At other times it is found to occupy the entire position of the Bottom coal; the natural inference being in such a case that it has entirely consumed the bed of coal. It has the effect also of altering the shales in contact and of partially calcining the ironstones, and rendering quite vitreous and porcelainic some of the fire-clays, in its passage through the strata.

In the Earl of Dudley's No. 38 Pit, Pensnett Colliery, (see section) every grade of hardness and colour of Basalt and Green and White intrusive Rock, have been found extending from the *White ironstone* (the lowest bed worked there,) up through the *Heathen coal*, the *Thick coal*, and up through the *Brooch coal*—a total height of more than seventy yards, and probably rising to the surface ninety yards higher. It is well ascertained that it has also passed vertically in every conceivable shape, like forked lightning, through all the intermediate coal shales which lie between the coals above-named.

It is perhaps worth observing here the disposition the Green Rock has to form concentric rings around a dense nucleous wherever large masses of it occur in the coal, (see section) much in the same way as nodular Basalt near the surface.

I have seen a block of five or six acres of the *Ten-yard coal* thoroughly explored, and it has been so penetrated by these

intrusive rocks in every conceivable form, and consumed to such an extent that not more than twenty-five per cent. of the original seam has been left, the rest being green and white intrusive rock. All coal and ironstone in the district coming within the influence of the Basalt or Green or White intrusive Rocks, are rendered more or less sulphurous and impure, and sometimes so much so as to render them almost useless for iron making purposes. Ironstone too, affected by it, is not only rendered sulphurous, but if it originally contained carbonate of lime, in the form of septaria, immediately it is brought to bank and acted upon by the rain, it *slacks* like lime, and the ironstone falls to pieces. This is especially observable in the white ironstone raised near the Rowley Hills. May not this then be due to the heat of the intrusive rocks having driven off the carbonic acid, and reduced the carbonate of lime to *lime?* Hence the atmospheric influence upon it when brought to bank.

It is very singular, too, that in districts affected by these rocks, although the coal is reduced to an anthracitic state, large quantities of exceedingly explosive gas is given off in the workings of the altered coal. The flame of which, however, is very often tinged with a crimson colour instead of blue, as with ordinary carburretted hydrogen gas. May not this crimson tinge and its unusually high explosive character, be due to the presence of carbonic oxide pent up in the pores of the altered coal, after the partial destructive distillation by contact with the intrusive rocks?

All the volatile products appear to have been driven off in the altered coal, which is locally termed "Black Coal," and it is only within the last few years that a mode of utilizing it has been discovered. That has been accomplished by the locomotive engine; and one firm in the district is now raising 200,000 tons per annum, which twenty years ago would not have been worth raising, or if raised, would have been used to build stables, hovels, or boundary walls to the colliery.

As regards the relative ages of the Basalt and Green Rock with the Coal-Measures, no doubt both occurred after the deposition of the whole of the Coal-Measures of the district, and before the innummerable faults occurred in the latter, for wherever the coals are thrown down or up by faults, so is the green rock.

The most remarkable instance of this is, the Dudley Port "Trough fault," which is thrown down north 130 yards, and thrown down south 130 yards, being about 200 yards wide at the bottom of the trough.

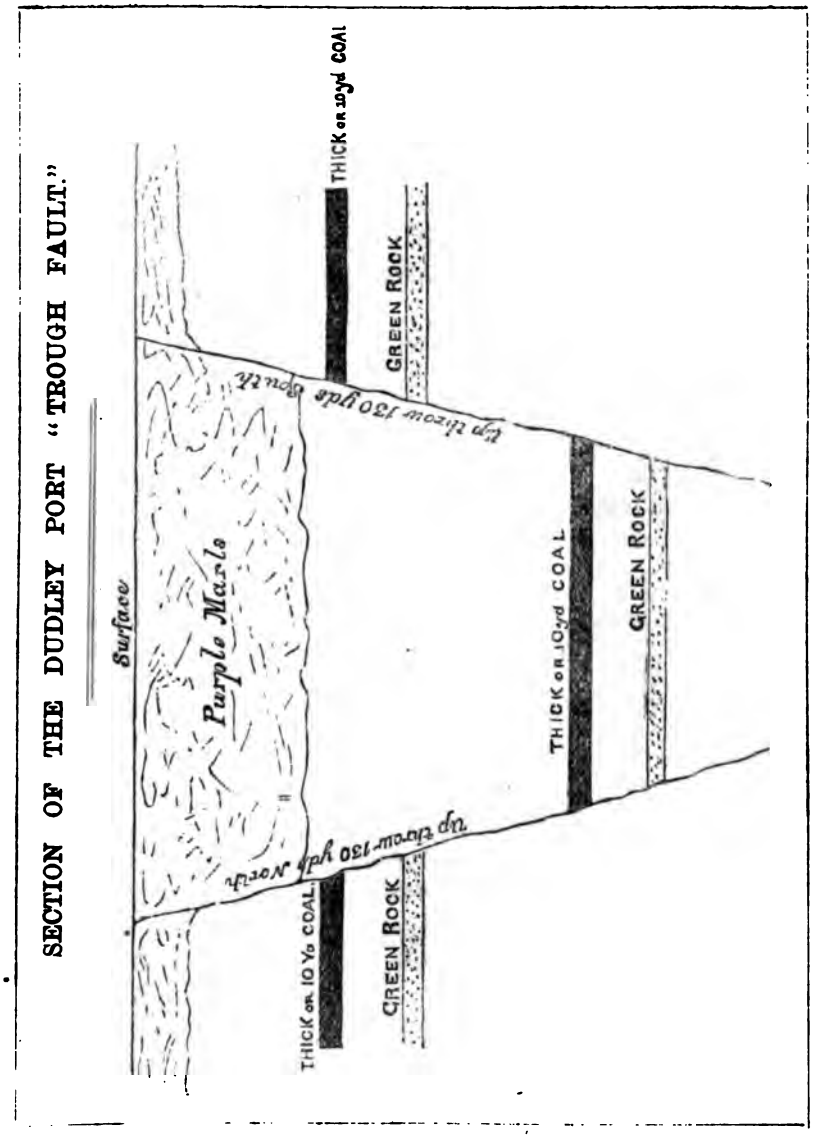
Here, as in every other case, the Green Rock is thrown down a similar distance to that of the coal above it.

Where the Green Rock is thickest and strongest, the more open are the natural joints or cracks in the rock, which are considered to have arisen from the cooling of the originally molten mass. These open fissures in the rock run in every conceivable direction, and are often a great nuisance to the sinker, who unwittingly lands his blasting hole on to one of these cracks and the force of the powder is spent uselessly in the chasm. To sink a seven feet pit shaft in this rock ranges from £6 to £35 per yard vertical.

I must now conclude by describing the exact position of the specimens, and at the same time express a hope that I have to some extent made myself understood, and that my very humble efforts in the common cause of science, may have afforded you some little interest and gratification.

The specimens of burnt shale before you, clearly illustrate the formation of the columnar structure of Basalt, so largely developed in the Giant's Causeway, in Ireland, and at Staffa and other

SECTION OF THE DUDLEY PORT "TROUGH FAULT."



places. The specimens have been accidentally formed in the hot ashes from a colliery winding-engine boiler, and are the only instances I have ever discovered wherein the principle of columnar structure produced by heat, is so clearly proved.

ANALYSIS OF "ROWLEY RAG" OR BASALT;

By Mr. Henry, of London.

Specific Gravity	2·907
Silicia	49·860
Alumina	12·750
Lime	8·710
Magnesia	4·395
Protox Iron	11·380
Peroxide of Iron, with Manganese	3·360
Soda	5·250
Potash	0·570
Titanic Acid	1·330
Phosphoric Acid	0·580
Water	2·560
	100·745

ANALYSIS OF THE INTRUSIVE WHITE ROCK, IN CONTACT WITH THE ALTERED COAL;

By Mr. Henry, of London.

Silicia	38·330
Alumina	13·250
Lime	3·925
Magnesia	4·180
Soda	0·971

Potash	0·422
Protox Iron	13·830
Perox Iron	4·335
Carbonic Acid	9·320
Water	11·010

Professor Jukes considers that the large per centage of carbonic acid and water in this rock is due to the altered character of it in contact with the coal, and that it has acquired these elements from the coal; but considers it extremely difficult to say whether this occurred immediately on its injection into the coal, or by slow aqueous infiltration during long subsequent periods.

This intrusive white rock falls to pieces almost immediately it comes in contact with the air.

THE ALLUVIAL GRAVELS

AT ORSALL LANE, SALFORD.

Mr. Plant exhibited some fossils which had been taken from alluvial gravels near the Ordsall Lane Railway Station. Amongst them were corals, originally belonging to the carboniferous limestone, which had been reduced to their present pebble form, and entirely desiccated so as to present the appearance and lightness of spongy siliceous corals. The specific characters were well preserved in the following: *Lithostrotion affine*, *Syringopora ramulosa*, *S. geniculata*, and *Clisiophyllum turbinatum*. An epigenic specimen of remarkable similarity to a fossil *Calerites* but without sufficient evidence of its being one; as well as two small flints, were also shewn, these were the only flints observed in riddling over ten thousand tons of these alluvial gravels, there may have been others overlooked; but flints are very rarely found in the gravels,

and never in the underlying boulder clay. In an examination of slices of the flints under a high power, sponges and shells of cretaceous forms, were found to be abundant.

The section at Ordsall Lane is at present very interesting, as the ground has been lowered twelve feet over about two acres. The made earth is followed by a light loamy deposit almost without pebbles, but filled with fragments of twigs and leaves. This averages four feet deep, and is followed by alluvial gravel from six to eight feet deep, with patches of sand here and there. The pebbles of the gravel riddle two of fine—inch and quarter meshes —to one of coarse; often at the lower part of the gravel big boulders, genuine erratics, are found, about fifty of these have been selected and placed in Peel Park, where a large collection of striated and rolled boulders is now to be seen. Below the gravel is boulder clay to a depth of twenty feet, varying, however, according to the erosion of the surface, which is furrowed into deep ruts and ridges running from north-east to south-west. A sewer is laid twelve feet down in the clay, and its section shews the clay to possess the usual tenacious character and purplish hue which belongs to it generally about Manchester. In excavating the ground several old wells were found sunk only through the gravel to the top of the clay, as the surface drainage-water was retained in the deep furrows above alluded to, at the top of the clay. None of the wells were lined with brick, being so shallow, but a few boards at the bottom kept them sufficiently open. Underneath the clay the Trias pebble beds are found, with a deeply eroded and unlevel surface. At one place, in the bed of the river where the pier for the new bridge for the branch railway was sunk, the rock was twenty-seven feet below the water-level; whilst a few yards off, the red rock crops out on the river bank.

Judging from the features here presented, it would appear that the Irwell river valley was formed by a deep denudation of the pebble beds of the trias, the surfaces of which were

left very irregular, with deep furrows and hollows. Upon these was deposited above twenty feet of boulder clay during the glacial period, as we find the rocks glaciated about 600 yards lower down the valley at Ordsall Clough.* The top of the clay was afterwards denuded and worn out into holes and furrows, over which the river gravels were strewn to a depth of eight feet, and lastly, at the top of the gravels, about forty feet above the present level of the river, the loamy silt was quietly deposited as it lies, in very fine laminæ. The river from that time has been decreasing its volume, and for many centuries back has occupied its present limited channel, with periodic floodings, which at their highest, as in November, 1866, only flood the low-level lands bordering the present channel, and would never reach these higher loams, even if the flood waters were thirty feet higher than they were ever known to be.

A vote of thanks to the President concluded the meeting.

* See Trans. Man. Geol. Soc., vol. vii., p. 40. On Glacial Groovings at Ordsall Clough.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 9.] VOL. VII. [Session 1867-68.

The Monthly Meeting of the Members of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, June 30th, 1868.

G. C. GREENWELL, Esq., F.G.S., President, in the Chair.

MR. BINNEY, in presenting to the Society Part I.—*Calamites* and *Calamodendron*—of his observations on the Structure of Fossil Plants found in the Carboniferous Strata, just published by the Palæontographical Society, said:—When we consider the great number of valuable specimens from the Coal-Measures of Great Britain, seen in our public and private collections, and see what has been done to bring them before the world, we are led to believe that our carboniferous Fauna and Flora, but more especially the latter, have scarcely had that attention devoted to them which their importance demands. If the curators of our public museums would describe the specimens under their charge, private collectors describe theirs, and the council of the Palæonto-

graphical Society lend its assistance in publishing, something useful might be effected. In addition, the aid of the colliery proprietors should be solicited, for the purpose of obtaining funds to enable the Palæontographical Society to engage the best artists. When this is done we are likely to possess a literature on our Carboniferous Fossils worthy of the first coal producing country.

At the present day some of the kingdoms on the Continent publish works illustrating the carboniferous Flora superior to what we do. The best way to remedy this is to subscribe to the Palæontographical Society, and for the wealthy landowners and colliery proprietors to furnish the funds which in other countries are contributed chiefly by the State, but in Great Britain are left to the liberality of private individuals.

The following paper was read:—

ON SOME

COPPER, IRON, AND OTHER MINERAL DEPOSITS

OF THE MARITIME ALPES,

IN THE DISTRICTS OF ST. SAUVEUR, VALDEBLORE, AND ST. MARTIN DE LANTOSQUE;

BY MR. P. S. REID, LONDON.

THE mines of St. Sauveur and Vandeblore are situated on the French and Italian frontier, about 35¼ miles, (57¼ kilometres) from the town of Nice, on the Route Imperiale No. 205, which road is intended to unite that place with Barcelonette in the department of the Basses Alpes.

The village of St. Sauveur, which is situated close to the Tinée, a rapid and considerable tributary of the river Var, is 1630 feet above the level of the sea, and a mountain about two miles to the north-east attains a height of 4467 feet. St. Dalmas, also a short distance to the east, is 4942 feet above the sea-level. These altitudes, although indicative of an extreme degree of cold in our latitudes, present no difficulty with reference to temperature in that district. All sorts of crops are found to flourish, and even the vine luxuriates in the neighbourhood, at nearly 5000 feet above the sea.

The predominant formation is, in the first place, the Jurassic Limestone, under which and reposing on the mica schists, are metamorphic rocks, answering in a great measure to our New Red Sandstone formation, and in these the principal deposits of copper, which we are about to describe, are found.

Beginning with the mines of Cluchlier, near Valdeblore, the whole structure of the mountain appears to consist of a series of red schists, alternating with parallel beds of white sandstone passing into quartzite, the mass being several hundreds of yards in thickness and resting on massive aggregations of gneiss, which come to the surface at Millefonts, and are there found to be prolific in veins of iron ore, of which we shall speak further on.

These strata of schist and sandstone are doubtless of sedimentary origin; but, according to all appearance, they must have submitted after their formation to the influence of heat, and have thus passed into the metamorphic state in which they are found wherever their contact has been sufficiently close to the micaceous and granitic rocks subjacent; and it must be observed that no organic remains, animal or vegetable, are met with, whilst in the Jurassic limestone, or lias immediately above them, are found quantities of Belemnites and Ammonites of gigantic proportions.

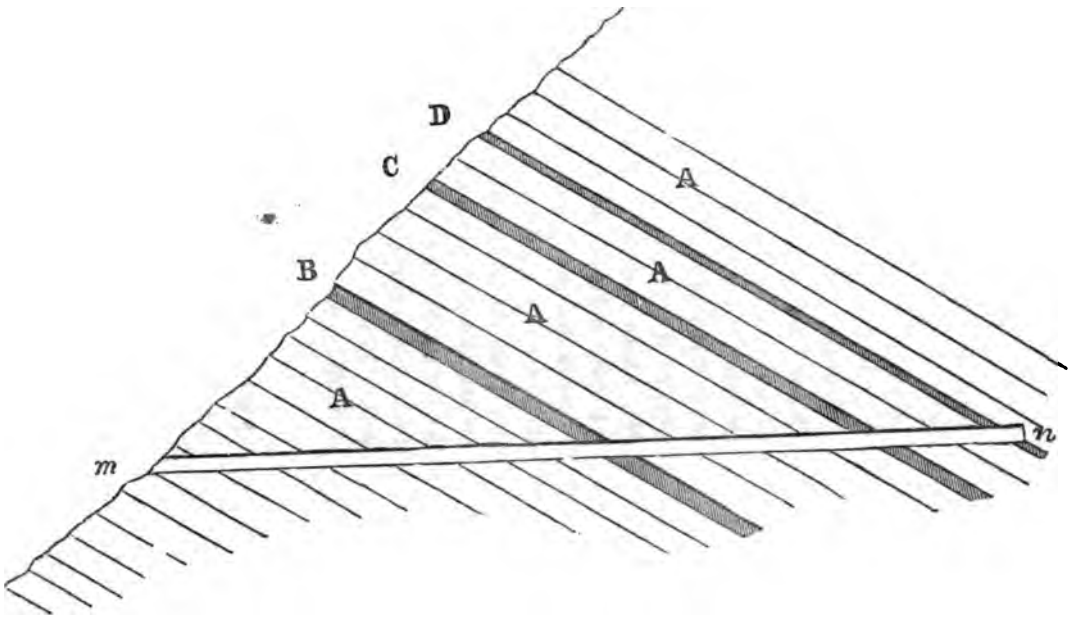
French geologists consider the position which these rocks ought to occupy in the Geological order of formations quite an open question. Some classing them with the shales of the lower Lias, some amongst the variegated sandstones of the Triassic system, and others even amongst the Permian rocks, in consequence of certain analogies with the copper schists of Mansfeld; whichever may be their true position, the strata in question are eminently metalliferous, and the whole series occupies an extensive area in the "Alpes Maritimes" extending over forty to fifty miles of country.

At Cluchlier, between Rimplas and the village of La Bouline, these beds crop out on the mountain side, and are distinctly apparent for more than a mile in distance. The following sketch will give an idea of the disposition of the metalliferous deposit and its enclosing rocks. The average direction of the beds is north and south, and they dip at an angle of 40° to the east. (See section on the opposite page.)

The lower bed **B** forms a deposit of Talcose schist mixed with small nodules of quartz, grains of carbonate of copper being diffused throughout the whole; fragments of Phillipsite ("cuivre Panaché,") or streaked copper, are also disseminated through it. The mean thickness of this seam being about five feet.

The intermediate deposit **C** is composed of a bed of sandstone passing into quartzite, spread through which are found numerous nodules of Phillipsite, and broad efflorescences of carbonate of copper, the average thickness being about two feet eight inches.

The upper deposit **D** appears the most important, containing as it does, Phillipsite or streaked copper, forming veins, nodules, and lenticular masses in the schists, which are in this bed frequently



A Beds of Red Schists and White Sandstones.
B Bed of Cupreous Breccia, (samples 9 and 22.)
C Bed of Sandstone, with copper ores, (samples 7, 8, 11, 12, &c.)
D Veins, kidneys, and masses of Copper Ores embedded in the schists.
m n Shews a cross-cut gallery driven to cut the beds.

spotted with carbonate of copper, constituting alone a poor but workable mineral. The mean thickness of this seam is one foot four inches.

Close to these outcrops are old workings of great antiquity, belonging in fact to an era very remote, as no document or tradition exists with respect to them. Common rumour attributes them to the Saracens, a very industrious people, who are known to have occupied the Alpes Maritimes during the eighth, ninth, and tenth centuries of the Christian era. At about a mile to the north-west of the "Saracen's Gallery," in the quarter of Trémisières, a large vein of iron ore much impregnated with carbonate of copper, is found, which renders it probable that on going deeper the iron may pass into copper, as is found in some of the great German veins similarly placed, where masses of ore are found taking the form designated a lode, enclosed in gossan, as in Cornwall. The sides of the vein in this case are similar to what has been described at Cluchlier, viz:—parallel beds of schist and sandstone, with this difference, that the schists instead of being red are whitish, and that the sandstones in place of being solid are found in a friable and tender condition, as if operated on by heat. The mean direction of this vein is north and south, with an inclination of 35° to the west. The direction of the deposit corresponding with that at Cluchlier, but the dip being quite contrary.

Nature and yield of the Ores.

On examining the records of the French School of Mines of Paris, the beds **B**, **C**, and **D** are classed in three varieties, as under:—

	Average yield in copper.
1st—Cupreous Breccia	3·2 per cent.
2nd—Copper Schist	4·5 „
3rd—Phillipsite (cuivre Panaché)	53·9 „

The last was a selected sample.

A piece of ore, partially decomposed from long exposure to the surface and atmospheric influence, was analysed with care and gave the following results:—

			YIELD IN COPPER.
CARBONATE	Water and Carbonic Acid ...	155	
	Dentoxide of Copper	·282	·227
SULPHIDE	Copper	·087	·087
	Sulphur	·045	·314
	Peroxide of Iron	·095	
	Gangue of Quartz and Clay Slate	·336	
		1·000	

It is curious to remark that during the last forty years more than one attempt has been made to work these copper ores on the place, and that each endeavour to do so has failed, from the parties working the mines, being infatuated and allured with the great yield of the Phillipsite. Hence, their efforts were directed entirely to the search for this ore, to the utter neglect of the inferior but much more abundant qualities.

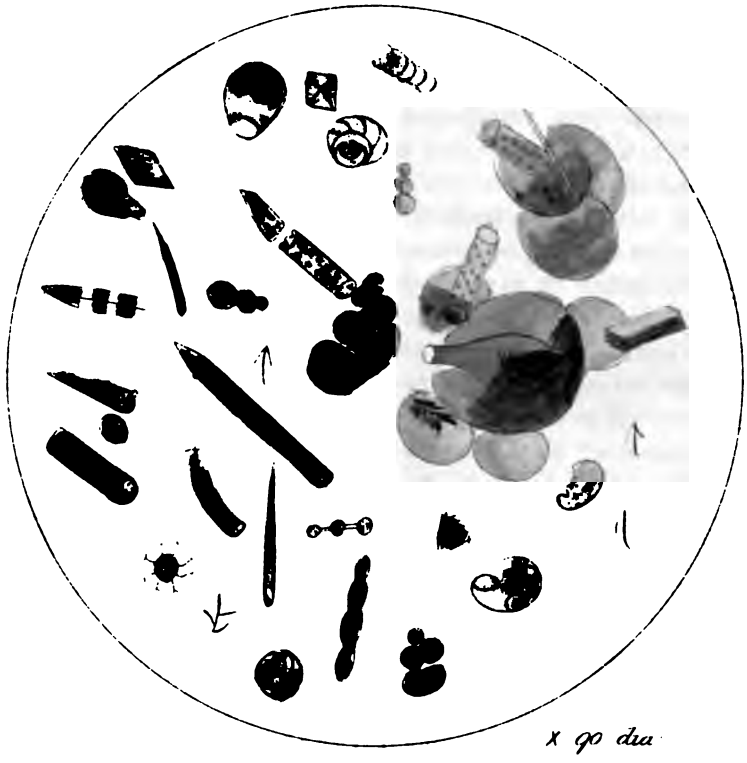
Till now, the cupreous breccia No. 1 and the copper schists No. 2, holding the metal chiefly in chemical, in contradistinction to mechanical, solution or mixture, have been thought, *and properly so*, too poor to be transported and sold to smelting works at Marseilles or in England; whilst their being chiefly ores of copper in solution, it has been inconvenient to treat them by washing on the spot, because by such a process the greater part of the carbonates would pass away with the stream which carries off the gangue in the washing process. For the same reason it is a question whether a similar treatment to that of the ores of Mansfeld would be effectual, as in the last-named the schists are enclosed in a bituminous shale, which permits of their being baked in heaps by means of

their own fuel. The most likely way of working these ores would appear to me to be precisely that adopted at Alderley, with some modifications suggested by their calcareous character. This process I need not describe—as it is no doubt well-known—further than to say, that the metal is to be dissolved out, either by muriatic or sulphuric acid, and reprecipitated upon plates of iron.

With reference to the rich ores, they are chiefly Phillipsite, which is found mixed with certain proportions of sulphide and carbonate of copper. The usual gangues are clay-slates and quartz; but there are also found in them accidental fragments of other minerals, such as sulphate of baryta, fluor spar, specular iron ore, and chlorite. As before stated, their nature is such that red copper and extremely rich mattes have resulted from them in the first melting. This is to be attributed to the reaction which occurs between the sulphur and the oxide of copper during fusion; and with such qualities it is needless to say the market is assured in England, no matter what the cost of carriage may be, since similar ores bear importation from Australia.

Immediately to the north of the village of Rimplas, and on the opposite slope of the mountain called Cluchlier, another formation of copper has been discovered. In the writer's opinion, these two deposits of copper, though differing greatly in character, will ultimately be found to be identical. It is well, however, to remark that the Rimplas formation partakes much more of the nature of the Cornish copper mines than that of Cluchlier.

In it you have a tolerably well defined vein or lode in one place, with its usual enclosing gossan or hydrated oxide of iron. It is placed about 2,788 feet above the sea level, and is separated from the Tinée, a river which, though called a tributary of the Var, is in reality its principal stream, by a distance of 2,000 yards. This stream being the southern limit of the concession, and having a



x 90 dia.

Polythalamia and Sponges in Flint

from Holcombe Hill drift, near Bury.

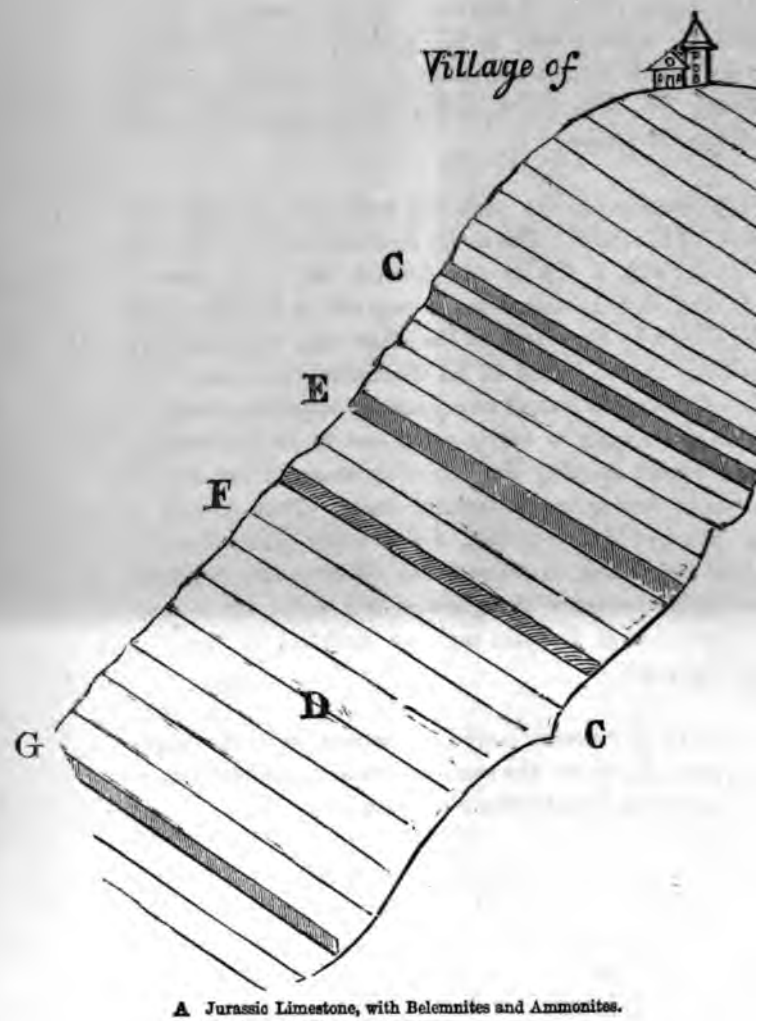
F.P

volume in the driest season of 424 cubic feet per second, presents great facilities for water power, in the washing and manipulation of the ores, both with reference to Rimplas and Cluchlier, and the Imperial Route No. 205, which passes the foot of the mine, will further facilitate its access.

Geologically considered, the enclosing rocks are precisely the same as those of Cluchlier. The mean direction of the beds being north 20° east, with a dip of 32° towards the east. Several metalliferous and carbonaceous deposits crop out on the side of the mountain, as shewn by the sketch on the other side; and both here and at Cluchlier in the valley of La Bonlinette, are found two distinct beds of anthracite coal, of an excessively sulphureous nature. These coals do not appear to me in either case to be conformable with the red schists forming the enclosing rocks of the copper formation, but to belong to the Jurassic series. They abound in nodules and kidneys of iron pyrites, and in many places the coal, where exposed to weather, is covered with efflorescences of nitrate of potass or soda; hereafter these seams will again be noticed. The whole formation at Rimplas may be sketched as in section on the following page.

The chief works of research have been carried on at the upper part of the deposit **E**, where the seam partakes undoubtedly more of the nature of a vein or lode than elsewhere.

The bed of quartzite and clay-slate, of which the thickness exceeds twenty feet, is penetrated in all directions by veins and nodules of copper pyrites, with considerable masses of green carbonate of copper (Malachite.) The ordinary gangues are all quartz, which gives it greatly the look of our Cornish ores in the mine. There are also occasionally sulphate of baryta, chlorite, and hydrated oxide of iron. The last-named, as well as the carbonate of copper, being evidently due to the decomposition of the copper pyrites.



A Jurassic Limestone, with Belemnites and Ammonites.
B Earthy and Siliceous Limestone.
C Seams of Anthracite Coal.
D Beds of White Sandstone and Red Schist.
E Copper Pyrites, enclosed in quartzite and clay-slate.
F Cupriferous Specular Iron Ore.
G Phillipsite (streaked copper) or "cuivre Panaché."

The deposit **E** has been opened out by an excavation thirty yards long, with a breadth and height of twelve yards. Several small galleries have also been opened out in the thickness of the metalliferous bed, including a crosscut of sixty-five to seventy metres, which has cut the deposit with fine ores.

Beneath the bed **E** is found a mass of micaceous specular iron ore, **F**, enclosing nodules of copper pyrites. Finally, on descending the ravine of Charontes, a small vein of half an inch to an inch in thickness, is seen interpolated in the beds of sandstone, of which the direction is north 80° west, with a dip of 68° to the north.

Yield of the Ores.

The result of various assays, as performed by the Paris School of Mines, is as follows:—

Selected Samples.

First assay yielded	...	...	...	23	per cent. of Copper.
Second „ „	...	...	...	27	„ „
Third „ „	...	...	...	22	„ „
Fourth „ „	...	...	...	21	„ „

The following is the analysis of the ordinary ore obtained from the deposit **E**—

Copper...	·159
Iron	·235
Sulphur	·188
Quartz Gangue	·400
Loss corresponding to the Carbonic Acid and the Oxygen of the Carbonate of Copper	·018
	1·000

The preceding sample submitted to a rough smelting with borax, gave a copper matte of the following composition :—

Copper...	·392
Iron	·357
Sulphur	·246
Loss	·005
	1·000

The assay of a piece of Phillipsite (cuivre Panaché) obtained from the outcrop G, gave a yield of fifty-three per cent, a result certainly suggestive of further researches as to the origin of so rich a deposit.

Analysis of the Coals from C.

The samples from this seam were outcrop entirely, and had been long exposed. They gave as follows :—

Volatile Matter (chiefly water	·190
Mixed Carbon	·707
Argillaceous Ash	·103
	1·000

The calorific effect of this fuel is found to be equal to 5989, or that of ordinary coal.

Some of these ores have again been analysed by Mr. J. A. Phillips, with the following results :—

No. 1.—Cupreous Breccia, "Cluchlier"	Copper ...	1·51	per cent.
„ 2.—Streaked Copper (Phillipsite)	... ...	44·70	„
„ 3.—Cupreous Schist, "Cluchlier"	... ...	13·87	„
„ 4.—Broken Ore, "Cluchlier" ...	... ...	34·10	„
„ 5.—Copper Pyrites, "Rimplas"	... ...	15·76	„

About sixteen to twenty miles to the south-west of Valdeblore or Cluchlier, another deposit of copper is found running over vast extents of country, in much the same kind of rocks as at Cluchlier and Rimplas; and over this large intervening space I do not doubt the copper-bearing rocks will be found continuous, but my time and the arduous character of the investigation, forbade the investigation. These mines are being worked by English capitalists.

I will not describe the exact geological position of the copper seams, they are so similar to those of Cluchlier; but the ores are of a totally different nature, the mineral being, if I may so express it, *mechanically* deposited in the grey sandstone rock, in contradistinction to the chemical intermixture as shewn at Cluchlier, and as found at Alderley. A simple washing and crushing suffices to clear off all extraneous matter, and the ores which in the bed contain only two per cent. of copper on the average, are thus enriched to twenty per cent. in the state of schlich, and in this form it is barrelled and sent off to Swansea from the Port of Nice. Specimens of this, as well as all the other ores, will be laid on the table.

In the same district are found a great variety of copper ores, amongst the rest, red oxide, black sulphuret, native copper, grey argentiferous copper, &c., &c.

The schlich obtained from some of the washed ores sent to Swansea, yielded as follows:— copper, forty per cent.; and silver, 29¼ ounces of that metal per ton of ores smelted.

The Government Engineers of Italy, of which country all these deposits formed a part till within the last few years, consider the copper deposits as greatly analogous to those of Mansfield. The writer does not think so, except in the mere deposit in seams, in contradistinction to veins; but the question is an open one.

Iron Mines, &c.

About three to four miles north of the villages of La Bouline, La Roche, and the Cluchlier mines, is situated the mine of Millefonts. Numerous outcrops of rich iron ores are traceable, (extending over 600 yards of space,) by excavations crosscutting several yards of ore in eight distinct veins. The concession occupies the northern slope of the pasture land of the mountain on what is called the "Col des Ferières," on account of its exceeding richness in iron ores.

The whole appear to be an aggregation of veins leading to a central point on the summit of the Col, all enclosed in gneiss, with a mean direction of north 25° east, and an inclination which appears to lay from 20° to 45° towards the east.

The minerals present two principal varieties, viz: micaceous specular iron ore, and compact red hematite.

These ores are very pure, and treated in a charcoal crucible have yielded seventy-two per cent. of iron. On both slopes of the mountain quantities of furnace slags are visible, indicating the former existence of ironworks around this mine. Several circular holes also exist, excavated in the rock, which evidently are the sites of ancient furnaces; yet, there exists in the country no written document or verbal tradition on the working of these mines. They are generally attributed in France to the industry of the Saracens, who occupied the district during the middle ages.

These iron veins seem to extend in the direction of Chastel, about two miles north-west of St. Martin de Lantosque, and about 4870 feet above the sea level, where similar ores are visible, with the addition of very rich and highly magnetic iron ores. This would give a total length of three to four miles to this formation.

They are all found in the gneiss, but the mean direction here approaches north 40° east, with an inclination of about 50° to the south-east. Selected samples yielded upwards of seventy per cent. of iron.

On the western portion of this concession a regular vein of massive galena, mixed with zinc blende, has been opened, with about five inches thickness of ore enclosed in gneiss passing into mica schist. The mean direction of this is north 65° west, with a dip of 30° towards the south. The assay of selected samples produced sixty-nine per cent. of lead with fourteen ounces of silver to the ton of lead worked.

These mines of iron, though exceedingly rich in metal, labour under the disadvantage of want of mineral fuel. Wood certainly exists, and in fair quantities, but in the present day the competition with coke-made iron is too serious to induce large operations in them. Railways and good roads may some day make these valuable deposits available. At present their superabundance is excessive in comparison with the means of treating them.

To treat them in the Catalan forges, so general on the Continent in wooded districts, would be perfectly practicable, and an excellent and economical "Spiegel Eisen" could be produced; but the Swedish and German ores are so abundant, and the means of transport so much more available, as to confine these ores to simply a local sale, which, being chiefly agricultural, cannot be of large amount.

I could not learn that these coals had in any case been utilised in the neighbourhood, and should be inclined to think their excessively sulphureous character would always debar them for domestic use.

France, as a great country, is exceedingly poor in minerals and smelting works; its fuel also, though separated into many isolated coal-fields, is still very deficient in quantity compared to that of its neighbours. The writer thinks that much of its metallic poverty is due to its want of good roads and communications, which it is evidently the part of the present Government to supply, and they are actively engaged in doing so.

When once these are completed, he is of opinion that many interesting and scarcely-known districts will be revealed to the geologist, and many facts of great interest to science will result. The climate also is so fine in these districts as to make many of them — now unknown — objects of great interest to tourists; and the want of so many items of moment in mineral industry, which England can well supply, will much promote an intercourse which has of late years been greatly on the increase.

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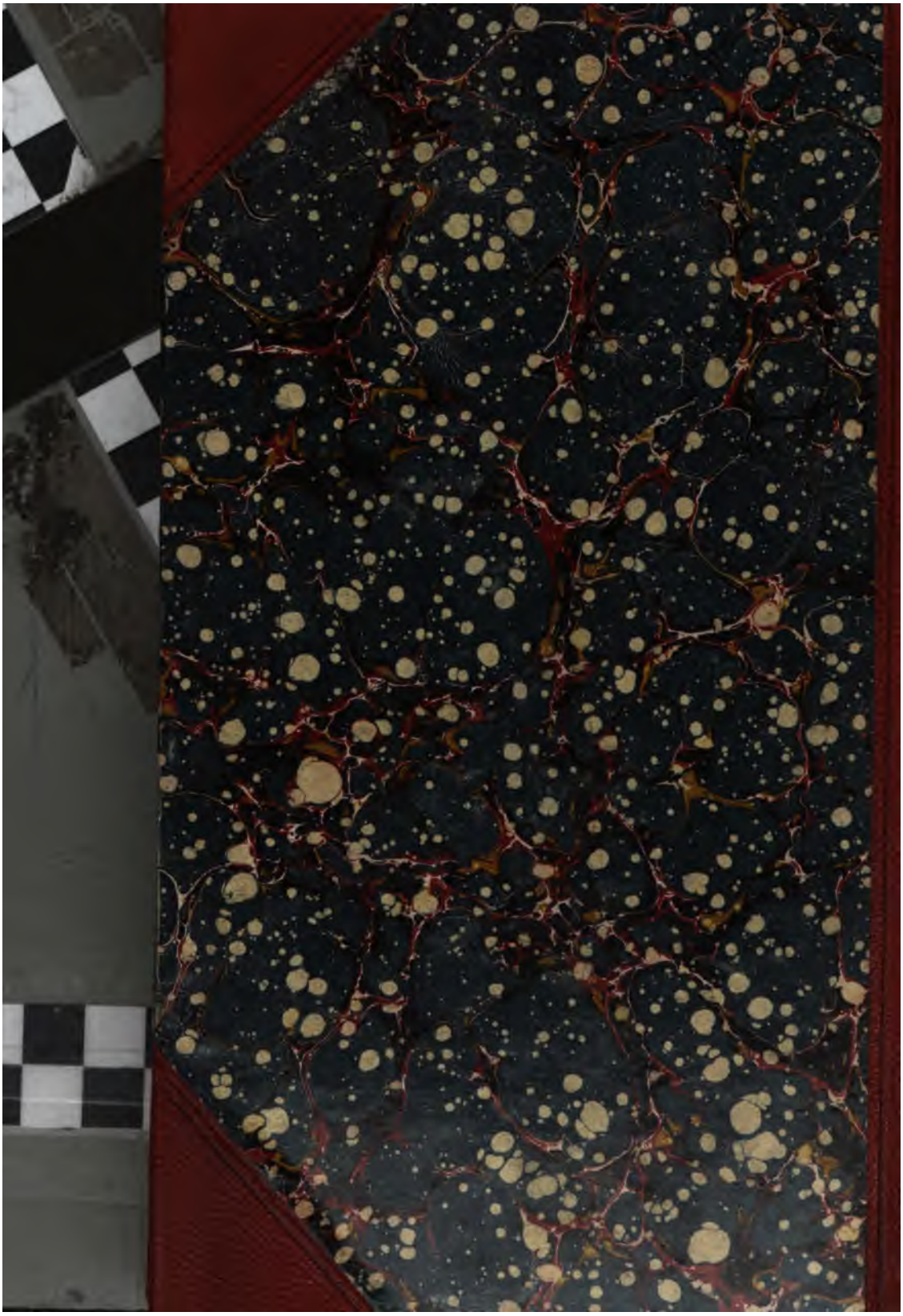
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